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A gusher near Shamrock, Oklahoma, that flows 2,500 barrels of oil a day  
OIL MAKES MILLIONAIRES—[See page 360]

# The Periodic Submergence of Europe\*

## An Examination of Hébert's Views of 1857

By Charles Schuchert

THE geology of France has long been notable for the detailed subdivisions of its periods of time, and much of its terminology has been adopted elsewhere in Europe. Alcide d'Orbigny<sup>1</sup> led the way in regard to the terminology, but Edm. Hébert appears to be the one to whom belongs the honor of first clearly pointing out that the oceans periodically but slowly and in an oscillatory manner invade the land—the more or less rhythmic and partial submergence of the continents by the oceans that is destined to give geology a determined and natural chronogenesis. Until recently the writer held that the idea of this resultant of diastrophism had its rise in Suess and Neumayr of Vienna, but the honor apparently goes to Hébert,<sup>2</sup> dating back to 1857 and thus to pre-Darwinian days. The modernism of his conclusions is striking and hence it is all the more remarkable that they have not been more clearly recognized in the standard text-books of geology. The writer now wishes to call attention to this brilliant paper by a great stratigrapher, and because there are but few copies of it in America, to present here in translation its main conclusions. The translations are by Miss Clara Mae LeVene. The first abstracts below are Hébert's conclusions in regard to some of the formational contacts of the Jurassic, and these are followed by others dealing with the delimitations of his "terrains," by which, as a rule, he means what we know as periods of time or systems of strata.

Previous to 1857, Hébert stated,<sup>3</sup> the geologists of France held that the periods of time "were the product of epochs of calm separated by cataclysms," believing that "the animals of each period had been destroyed by immense cataclysms which, elevating the mountains, violently agitated the seas and drove them over the continents." These theoretic ideas, Hébert says, are far from true, and adds, "We can boldly state as a principle that the most absolute calm . . . is the distinctive character of the separation of the [Mesozoic] terranes" in France.

In regard to formational contacts, Hébert says:

**Lias-Lower Oolite boundary.**—We conclude that the physical conditions in the midst of which the sediments were deposited changed in a rather marked manner at the boundary between the two epochs. The beds of the Upper Lias, with their numerous cephalopods, tell of waters which were quite deep. The disappearance of these animals at the base of the Lower Oolite, and the presence of many little polyps in the east, and of rounded pebbles in the west, indicate the nearness of the shore, or waters which were very shallow. There was, then, at the end of the Lias, in the Paris basin, an elevation of the land, and when the waters, which had become deep, were again inhabited by cephalopods, the species were entirely different (page 23).

**Lower Oolite-Upper Oolite boundary.**—In both east and west we find the Lower Oolite represented by an entirely similar fauna and bearing on its upper surface the traces of denudation and other phenomena indicating a time of arrest in sedimentation and an upward movement of the crust. At either limit, the millet-like oolite is an infallible horizon marker. Between the two formations, in the east, is found the Fuller's Earth, with its maximum thickness. In the west, on the contrary, the absence in the Sarthe of any kind of sediments shows that during a very considerable time—long enough for the accumulation of the thick beds of *Ostrea acuminata* and other fossils—the land remained emergent (31).

**Great Oolite-Oxford boundary.**—At the time of the Great Oolite, the seas throughout the Paris basin were constantly shallow, and it happened many times that in one place or another more or less extensive areas were raised so as to be at the level of the sea. But these partial elevations did not hinder the dominantly downward movement, as a result of which the seas rose more and more along the shore of the basin. This movement, whose origin goes back to the Trias, continued to the end of the Great Oolite, interrupted momentarily, either in a general way, as at the end of the Lias, the Lower Oolite or the Great Oolite, or in a local way, of which the Great Oolite offers us numerous examples (33).

**On isostasy.**—During the first half of the Jurassic [i.e., previous to the Oxfordian] the sediments that accumulated on the bottom of the basin helped by their weight to increase the depth of it [the older idea of isostatic balance]; however, this overloading could not explain the widespread sinking of the shores, accompanied by the intermittent elevations which divided the Jurassic into distinct epochs, each characterized by a particular fauna. Without doubt, although in reality this overloading did produce results which must be taken into account, it was not the principal cause of these movements of the land. That cause is more general (40).

**Coral Rag-Kimmeridge boundary.**—The characters of the Diceras limestone indicate a shore deposit laid down under similar conditions extending over a lapse of time of a truly prodigious duration. At the time of the deposition of the higher Astarte limestone, the conditions changed almost abruptly, although there is an alternation at the contact. The new causes which brought about the muddy sediments did not at once predominate; there was a struggle, so to speak, but the contrast is none the less striking. Without doubt, like events can be shown within the same stage; but when they are accompanied by a change of fauna, as considerable as the one we have shown, there is at this horizon a line demarcation of a certain importance (59).

**On oolite formations.**—Let us seek, by examining what takes place today in nature, to reconstruct the conditions necessary for the formation of oolitic limestones. Waters not muddy, saturated with carbonate of lime, a warm climate, abundant evaporation [now known to be due to the action of denitrifying bacterial], precipitation of lime at the surface, either around little particles of shells or sand, or even about little crystals of carbonate of lime, immense areas washed periodically by slightly agitated seas, a constant to-and-fro movement to roll the little bodies while they are being encrusted by the lime: we may figure that such conditions were maintained long enough for the accumulation of the oolites to produce masses 100 m. in thickness, not only at restricted places, as can be observed today in the Antilles, but over the whole extent of the Paris basin.

Then, all at once, the scene changes, the oolites disappear, the waters become dirty, deposit mud, and nourish an abundance of *Panopeas*, *Pholadomyas*, and other molluscs to which the new conditions are more favorable; and these new conditions continue until the end of the Jurassic, long enough for generations of species to succeed each other in the midst of a common fauna (66).

**Secondary crustal movements during the period of emergence.**—The second period of the Jurassic, which we have named the period of elevation, had for its dominant character a slow elevation of the crust which determined the progressive retreat of the sea, so that the consecutive shores which we can follow today with considerable exactness approach more and more the center of the basin. But just as, in the preceding period, the general subsidence of the basin was not the result of a uniform movement, but there were times of arrest and oscillation over more or less extensive areas; so, in this second period, the progressive elevation was subject to the same irregularities, as is proved by the state of the sediments of the epoch.

Thus, the Oxford is a great deposit of clay or more or less marly limestones, i.e., of sediments laid down in a state of mud in quiet waters, wherein lived great numbers of quite large cephalopods for which waters of a certain depth were necessary. That the Coral Rag, from its contact with the Oxford clay, was deposited in shallow waters, under physical conditions altogether different from those of the preceding epoch, is evidenced by the abundance of zoophytes, often in their original places of growth, by the nature of the oolites which make up almost all of its mass, by the pebbles or water-worn fossils which occur so abundantly, and by the almost complete absence in the Paris basin of cephalopods. The Kimmeridge clay, including the Astarte limestone and the Portlandian limestone, has exactly the same character as the Oxford clay. However, it is to the beginning of the Portlandian limestone that the maximum depth of seas must correspond; the end of the Jurassic, on the contrary, marked by the Portlandian oolite and subordinate beds which do not appear to have been as widespread as the preceding formations, saw very shallow waters covering no more than the center of the basin. Soon the sea withdrew

completely, and the greatest depression was occupied by fresh waters, whose sediments are quite analogous to the Purbeck beds.

This progressive upward movement terminated in the emergence of the basin, which, though not a state of absolute immobility, lasted during considerable time.

It is to be noted that the same upward movement occurred not only in the basin of Aquitaine, but in the Alps and the Jura as well. There, as in the Paris basin, the Upper Jurassic beds of the Oxfordian stage are superposed, each one "in retreat" with respect to the preceding. The sea withdrew from this region at the end of the Jurassic, and the final depression was occupied by fresh waters before the time of the Neocomian, according to Lory. This shows that the Paris basin took part in a very general movement which affected the Aquitaine basin, the Jura and the Alps, i.e., almost all of France and probably a great part of Europe.

If we seek to fix exactly the secondary movements during the emergent period, we shall see that the depth of water must have increased during the whole of the Oxford clay. With the beginning of the Coral Rag, and probably also after quite a long interruption in sedimentation, the upward movement again predominated. Then appeared a considerable change of fauna without gradual transition. Thus, at the end of Oxford time there was not a polyp left in the Paris gulf; at the beginning of the Coral Rag, on the contrary, zoophytes were widely spread and the mode of sedimentary formation followed altogether different laws.

During the deposition of the Coral Rag the waters remained shallow. The crust subsided at the beginning of Kimmeridge time, and another upward movement began at the end of the deposition of the Portland limestone (79-81).

**Hébert's Conclusions.**—We have shown that the crustal movements were not at all peculiar to the Paris basin, but that they also affected the ancient rocks which form the circumference of the Paris depression. These movements are so coordinated that we can consider them as being part of a single great oscillation composed of two periods, one during which the crust was slowly and progressively depressed, the other during which it was raised.

Each of these periods was itself divided by secondary oscillations, because of which the land was successively lowered or raised, but in such a way that, during the first period, the sea, in each one of these secondary oscillations, finally gained some land, while, on the contrary, it lost some during the second period.

These movements of the crust had more or less influence on the distribution of the lands and waters, and consequently on the climates, and from this came the changes in the organic realm. These changes can be appreciated today only through the remains of marine animals which accompany the sediments of each epoch. They alone, however, are numerous enough to form a sufficient assemblage of facts.

When, as a result of this movement, the change in physical conditions was considerable, the organic modifications were profound. Moreover, it seems evident that the maximum change must correspond to the maximum elevation of the earth and the minimum to the maximum depression. The maximum elevation, when the lands are most emergent, corresponds to the moment when the sea is farthest away from the point under consideration, where there is consequently the longest absence of sedimentation; the two beds nearest to this limit are, then, those which will differ the most.

Let us apply this fact to the present case. In the Jurassic epoch there were two maxima of elevation, one at the beginning, the other at the end. To understand these better, we must investigate the movements which took place during the Triassic and Cretaceous epochs.

During the Triassic epoch, at the time of the deposition of the variegated sandstones, the eastern part of the Paris basin was a shore; the sea occupied it at the time of the Muschelkalk, and left it at the time of the variegated marls. The Triassic was, then, deposited during an oscillation of the crust, which had been depressed up to the time of the Muschelkalk, to rise again at the time of the deposition of the variegated marls. The limit between the Trias and the Lias therefore corresponds to a maximum of elevation. Our countries had been for a long time above the waters of the sea, and when the latter came to occupy them anew, either

\*American Journal of Science.

<sup>1</sup>D'Orbigny, Cours élémentaire de paléontologie et de géologie stratigraphiques, 1849-1852.

<sup>2</sup>Hébert, Les mers anciennes et leurs rivages dans le bassin de Paris, ou classification des terrains par les oscillations du sol. 1<sup>re</sup> Partie, 88 pages, Terrain Jurassique. Paris, 1857.

<sup>3</sup>Hébert, Sur les phénomènes qui se sont passés à la séparation des périodes géologiques. Bull. Soc. Géol. de France, (2), xvi, 1859: 596-605.

because of the lapse of time in the interval, or because of the change in physical conditions which was the result of the new order of things, there was also a considerable change in the fauna.

During the Cretaceous epoch, we see the sea again advancing more and more into the Paris basin, the Neocomian strata being deposited in the center of the depression, the Gault exceeding the limits of that stage and extending toward the Meuse, the Ardennes, Boulonnais, Bray and Normandy—points that were previously out of water, although remaining a part of the Paris basin; the chloritic chalk and the tuffaceous chalk extend much farther and so show that up to this time the waters were rising constantly along the shores of the basin, and that they ended by breaking through completely toward the eastern border. The land was therefore more and more depressed during all this part of the Cretaceous period.

The study of the movements of the crust is useful not only for the establishment of the great divisions of the geological classification, i.e., the terranes, but no less so for the secondary divisions or stages. We see, in fact, that it is natural to divide the Jurassic terrane

into two corresponding parts, one the period of depression which includes the Lias, the Lower and the Great Oolite, that is, the Lower Jurassic terrane; the other the period of elevation, which is composed of the Oxford clay, the Coral Rag, and the Kimmeridge clay, to which we should add the Portlandian limestone, that is, the Upper Jurassic terrane.

Our two periods can be subdivided very clearly with the aid of secondary oscillations, whose duration, although very short in comparison with that of the great oscillation, was nevertheless immense in each case. We have proved by a great number of facts that the limits of these secondary movements coincide exactly with those of the stages fixed by the most certain characters borrowed from the domain of stratigraphy and paleontology. In this way our stages are distinguished one from another as follows: (1) in that they each belong to a different secondary oscillation, separated from the preceding and the following one by times of arrest corresponding to an emergence of the land and consequently to a break in sedimentation; (2) in that the line of contact is in general broken, often marked by denudation, and always easy to recognize when one includes no very

considerable extent of terrane; (3) in that the faunas of these stages, thus limited, differ much more from one another than happens in any other method of classification.

In each of these stages [he names six for the Jurassic] we recognize constant fossiliferous horizons in the whole basin, belonging to systems of beds often easily distinguished by their mineralogical characters, although there may not be between them sharply defined limits, either mineralogical or paleontological; these are the formations which make up the stages. Their characters depend also on the physical and mechanical conditions which presided over their deposition; they differ especially because of the variable depth of the seas, but they pass from one into another because they were formed during the same secondary oscillation. They are themselves subdivided into beds, sometimes very numerous, whose characters may be maintained for great distances, like the bed with *Amm. primordialis*, or may vary at neighboring points. This fourth method of division, however, although indispensable for local descriptions, cannot enter into the classification of a more extended area.

### The Carriage of Disease by Insects\*

By L. O. Howard, Bureau of Entomology

In his opening remarks the speaker called attention to the fact that the whole great field of the carriage of disease by insects has been developed within the last twenty years. He showed that in the standard medical works of twenty years ago, such as for example the 1895 edition of Osler's *Principles and Practice of Medicine*, there occurs absolutely no mention of insects in connection with the etiology of disease, either of man or of the higher animals; yet at the same time he showed that as early as 1889 Theobald Smith had discovered the causative organism of the so-called Texas fever of cattle (*Babesia bovis*) and that with the experimental aid of F. L. Kilbourne he had shown that this organism was carried from southern cattle to non-immune cattle by the so-called southern cattle tick (*Margaropus annulatus*), the results of this experimental work having been published in 1893.

Even before this, however, Dr. Patrick Manson, now Sir Patrick Manson, had demonstrated the carriage of the parasitic worm, *Filaria nocturna*, responsible for certain of the diseases grouped under the name filariasis from mosquitoes to man. Manson's discovery was, however, by no means so significant as that of Theobald Smith. The announcement of Smith's discovery, however, coming from a veterinary service, and published in the annual report of the Department of Agriculture, unfortunately received little attention from the scientific world in general.

The initial discovery which attracted world-wide attention was that of Ronald Ross, in India, who found that malaria is carried by certain mosquitoes.

The speaker here digressed in order to give his views concerning the recently agitated theory of the transmission of infantile paralysis by insects. He said:

The whole country was interested and alarmed at the occurrence of an unusual number of cases of infantile paralysis during the past summer (23,970 in all, with 2,072 deaths out of a total of 7,925 cases in New York city alone), and many theories were advanced concerning its method of spread. I must confess that when it was announced that the causative organism had been found in the intestinal passages as well as elsewhere and that it probably enters the body of the patient through the mucous membrane of the mouth and nose, I instantly thought of the house fly and the all-too-frequent contamination of exposed food by this insect, frequently fresh from intestinal discharges. But a second thought showed me that were such a method of conveyance of the disease possible the disease itself would be much more common, and there would have been last summer very many thousands rather than many hundreds of cases. Then too, the not infrequent winter cases could not very well be fly-borne.

Mosquitoes have been suggested as carriers, and a well-reasoned paper by Dr. Mark W. Richardson, of Boston, was published last September, under the title "The Rat and Infantile Paralysis," the rat-flea of course being the theoretical carrier. But rat-fleas go to human beings only in the event of epidemic disease among rats, and nothing of the sort has been noted in connection with any of the larger epidemics of infantile paralysis.

Moreover in inoculation experiments, reported by Flexner and Lewis, the virus is present in the blood of inoculated monkeys in such high dilution that the infection in a normal animal is accomplished only by inoculation of 20 cc. or more of the blood. If this holds under normal conditions, it becomes absurd to accuse any biting insect of the carriage of this particular disease, except in the possible event of the development of the organism in the body of the insect. While this possibility should be studied, the probabilities are against it. The impression which all of us, in Dr. Flexner's

audience, at his lecture, given December 28th, in New York, gained, was I think, that we are still greatly in the dark in regard to this disease, but that possible insect carriage must probably be ruled out.

It was then shown that it is necessary to divide the field under discussion into three categories:

1. Insects as simple carriers of disease, the accidental carriers as it were; that is, insects frequenting places where disease germs are likely to occur and conveying these in their stomachs or on their bodies to food supplies. This is notably illustrated by the house fly.

2. Insects as direct inoculators of disease. These are biting insects which feed upon diseased men or animals and carry the causative organisms on their beaks and insert them into the circulation of healthy animals. In this way anthrax is carried by biting flies; surra is carried in the same way, as is also the nagana or tsetse-fly disease of cattle. So also is bubonic plague carried in this manner by rat-fleas, but here there is more than a passive carriage, as is also the case with the tsetse-fly disease.

3. The third category, and this is perhaps the most important, includes insects as essential hosts of pathogenic organisms. These are the cases in which the parasitic organism undergoes its sexual generation in the body of its insect host and another, non-sexual, generation or generations in its warm-blooded host. To this class belong the malarial mosquitoes, the yellow-fever mosquito, and the rapidly increasing number of species that carry trypanomiasis, leishmaniasis, spirochaetosis, and the ticks that carry relapsing fevers and other fevers of man and animals, and the lice that carry typhus fever.

Under the first of these three categories the house fly was considered at some length, and cockroaches, ants (especially the household ant), the latrine fly (*Fannia scalaris*), and other insects were mentioned rather incidentally.

Under the second category the biting flies that carry anthrax were mentioned, and illustrated (as, in fact, was the entire address) by lantern slides. Under this head also, carriage of bubonic plague by rat-fleas was discussed at some length.

Under the third category, insects as essential hosts of pathogenic organisms, attention was called to certain tapeworms which have alternate hosts in insects or other arthropods and domestic animals, especial mention being made of *Hymenolepis diminuta*, which lives commonly in the intestines of rats and mice and has, as its alternate hosts, certain insects which feed in meal, so that man may become affected by eating dejecta of such insects in dirty cereals. The carriage of *Filaria nocturna* by *Culex fatigans* (*quinquefasciatus*), and Ransom's discovery of the house fly parasite *Habronema muscae* as a stomach parasite of the horse, and the pig parasite (*Echinorhynchus gigas*) sometimes occurring in man, with its alternate hosts as the larvae of cockchafer in Europe and the common white grubs (larvae of *Lachnosterna*) in the United States, were described.

Then followed a longer consideration of mosquitoes and malaria, and mosquitoes and yellow fever.

Under the head of trypanomiasis, the carriage of the nagana of African cattle by *Glossina morsitans* and the sleeping sickness of Africa carried by *Glossina palpalis* were mentioned, as well as the wasting disease of children in Brazil, known as opilacoe, caused by *Trypanosoma cruzi* and possessing a definitive host in the large biting true bug *Conorhinus megistus*.

Then followed a consideration of insects and leishmaniasis, ticks and spirochaetosis, including some detailed account of ticks and the Rocky Mountain

spotted fever. A fuller consideration was given to typhus fever and lice.

Stating that the carriage of typhus fever by the body-louse was first demonstrated by Ricketts, in the City of Mexico, where this discoverer lost his life from this fever in the course of his investigations, mention was made of the tremendous death rate from this disease during the last Balkan war in Serbia, and its destructive appearance in many places during the present great war. It was shown that at first the information put out by the medical departments of the different armies was insufficient and in many cases illy based. Especial mention was made of the publications issued in England, France and Germany, the extraordinarily detailed observations by Haase, made in Germany in the camps of Russian prisoners, receiving special consideration. He showed that more recently an intense investigation has been carried on in many places of all of the aspects of the biology of the body-louse. He showed that in the current number of the *Bulletin of the Pasteur Institute of Paris* (December 15th, 1916) reviews had been found of 17 papers, under the heading *La Lutte Contre les Puciers*. One of these was written by a Japanese, four by Englishmen, seven by Germans, one by a Swiss, two by Frenchmen, one by a Russian, and one by an Italian. He pointed out especially the very perfect proof adduced in one of these articles of the transportation by wind of the body-louse, a very important point to be considered in sanitary measures.

In concluding, the speaker referred to a manuscript table drawn up by Mr. W. D. Pierce, from the recent literature, which indicates that discoveries have been recorded of 226 different disease organisms as carried by insects to man or animals; that 87 organisms are known to be parasitic in insects, but not known to be transmitted, and that 282 species of insects are recorded as causers or carriers of diseases of man or animals.

The concluding paragraphs of the address are quoted:

But now we must stop. There are many subjects in the field which we have not touched. Tick paralysis, for example, is a most interesting and novel subject. This disease occurs in Australia, Africa and North America. In Oregon 13 cases have been found in the practice of a single physician. The attachment of a tick brings about progressive paralysis involving motor but not sensory nerves. It seems a unique malady. Hadwen and Nuttall, showing that it is not infectious and that there is apparently an incubating period in the tick, suggest a specific causative organism, but others hold to the theory of nerve shock.

Attention should also be called to the fact that, in spite of the host of discoveries, already well established, there is a dangerous tendency to exaggerate the importance of insect transmission, and to overlook, even in cases where insects may occasionally be concerned, the greater importance of other modes of infection. This is indicated by Sambon's theory of transmission of pellagra by *Simulium*—a theory which was advanced with enthusiasm on the ground that it fitted into the known facts in the epidemiology of the disease. It took two years of hard work on the part of members of the force of the Bureau of Entomology, working in collaboration with the Thompson-McFadden Pellagra Commission, to upset this theory in a thoroughly scientific manner. As has been pointed out several times of late, there is always considerable danger in conclusions based on epidemiological findings. Transmission experiments are necessary.

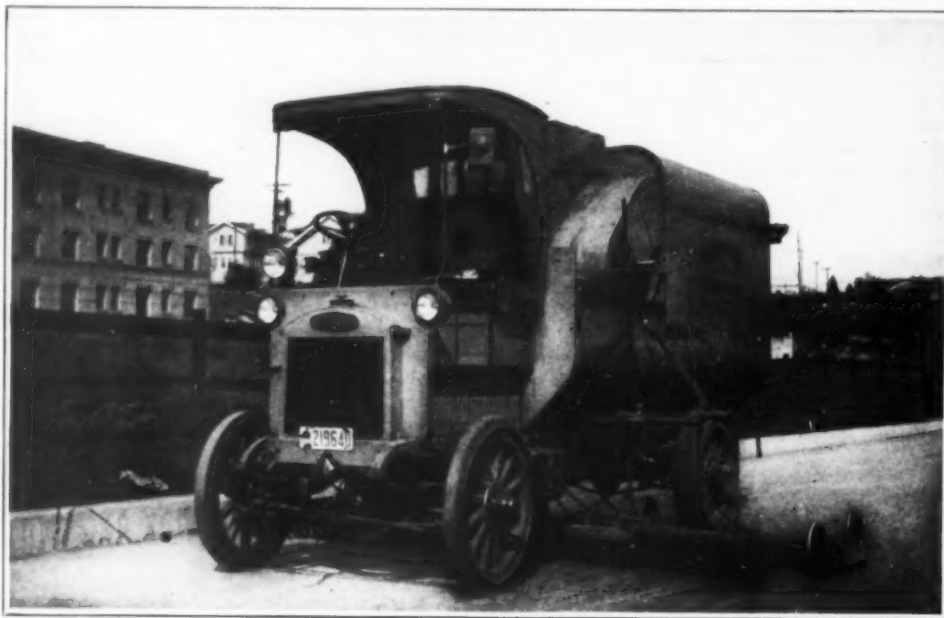
One conclusion must be drawn which can hardly be disputed: There is an enormous field for the entomologist in the careful study of all of the aspects of the biology of not only those insects which have already been shown to be disease carriers, but of those which are likely to be implicated. It is to the trained economic entomologist that we must look for the methods of destruction of these insect carriers, and the prevention of this class of diseases lies at his door rather than at that of the physician. Either that, or sanitarians must be trained in what is now known as medical entomology.

\*Address as retiring President of the Washington Academy of Sciences, delivered February 1, 1917. Abridged by the author and republished from the Journal of the Society.

### A Vacuum Cleaner for Use on Streets

By Frank C. Perkins

THE accompanying illustration shows a novel vacuum street cleaning machine used in the City of Los Angeles, Cal. Four of these street cleaning machines were contracted for, conditioned on the cleaning of 1,200,000 square yards. Two machines have been in operation since October 2d, 1916, and four machines since October 31st. The machines are worked in two shifts of eight hours each, one day shift (from 1 P. M. to 9 P. M.) and one night shift (9 P. M. to 5 A. M.). The machines are equipped with different width brooms, or sweeps, ranging from 12½ feet to 13½ feet. With a 13-foot broom, each sweeper cleans from 130,000 square yards to in excess of 200,000 square yards per day of eight hours, and operates at a speed of 3½ miles per hour and during an eight-hour day travels from 25 to 30 miles. The sweepings are deposited in a receptacle of two yards' capacity which is dumped twice each day at convenient collecting points. The machines are used on pavements with a smooth surface such as asphalt, oil, macadam or brick; probably 99 per cent of the area swept is asphalt pavement. It is doubtful whether the machines will do satisfactory work on rough pavements, such as granite blocks, as the broom or sweep could not come in contact with the whole surface, but on smooth, dry streets they do satisfactory work. They will not clean, wet or muddy streets, but are well adapted to work such as Los Angeles requires, as there is little wet weather and practically all of the paved streets are asphalt.



A vacuum street cleaning machine

### Extracting Benzol from Coal Gas\*

THE recovery of benzol from coal gas, an old problem of fifty years ago, was urged upon the gas industry a few years before the outbreak of the war, when the outlook of the supply of motor fuel looked threatening. The statutory requirements of a minimum illuminating power in gas stood in the way. A compromise was effected by fixing a calorific standard for coal gas; but it required the stern demands of the war to sweep away old traditions and to indemnify gas companies, at any rate, against any deficiencies in illuminating power caused by extraction of benzol and toluol from the gas for munition purposes. Under these conditions many gas undertakings, and in particular coke-oven works, have taken up the benzol extraction, and a considerable portion of the benzol supply of the country is now gained in this way. The principle is much the same in most of these plants. The gas is scrubbed or washed with some absorbent oil, and the absorbed hydrocarbons are subsequently distilled from the "benzolized" oil; the oil is cooled and returned to the scrubbers or washers. The term "crude benzol" is used in a broad sense; the benzolized oil may contain various hydrocarbons and also sulfur compounds. The scrubbers may be of different descriptions; the chief absorbent oils are creosote oil, green oil and gas oil; undistilled tar is also used, an old proposal of Friedlaender and Quaglio, of 1887. But the stills and the efficiency of the absorption might be much improved and the need for a simple and reliable method of controlling oil-washing operations is generally recognized. We have in our notices of oil-cracking processes had to refer to the unsatisfactory character of the means used for collecting and identifying the products. In view of these difficulties the Ministry of Munitions permitted Dr. R. Lessing to communicate the result of some experiments of his on "A New Method of Extracting the Volatile Constituents from Coal Gas" to the Society of Chemical Industry, in their January meeting at London.

Dr. Lessing recommends "dry scrubbers," charged with a solid absorbent material, which he impregnates with some oil. His second chief point is that he removes the absorbed vapors by distillation (with the aid of steam) *in situ*, without transference to a still. The method was suggested to him, some years ago, by the observation that spent iron oxide from gas works absorbed hydrocarbons and carbon disulphide owing to the tarry matter and sulfur in the oxide. That absorptive

power for hydrocarbons was indefinite, however, and the spent oxide induced chemical side-reactions. Dr. Lessing then experimented with pitch crushed to pea size; but the pitch started running, and the passages between the grains became clogged. From a material of high viscosity like pitch he, therefore, turned to oils of low viscosity incorporated into highly porous inert materials which would retain those oils and not allow them to be thinned unduly and washed out by the solvent vapors they absorbed. The absorbent oil was thus to remain quiescent and to behave as a solid so far as contact with the gas and the formation of back pressure—a feature of some importance—was concerned.

The inert material used, Dr. Lessing explained, con-

absorbed vapors was rather an advantage, as the more viscous oil would be more readily retained by the pores. As regards the time of contact necessary to ensure efficient absorption, the dry scrubber was also superior to the irrigated (spray) scrubber and to the bubbling apparatus; the oil locked up in the dry scrubber had a chance to saturate itself with the vapors.

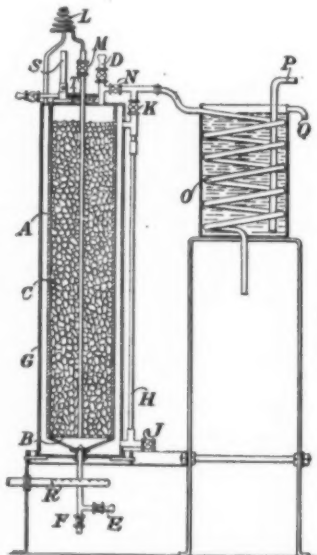
We illustrate in Fig. 1, annexed, a diagram of the neat apparatus with which Dr. Lessing has been experimenting during the last two years, in his own laboratory, and also in several gas works. The oil-soaked material rests on the perforated bottom B of a cylinder container A. The gas enters through the stop-cock D and passes downward through the material and through the outlet

E into the gas meter, which Dr. Lessing prefers to arrange after the scrubber in order to prevent condensation of vapor in the meter itself. The gas leaving the meter is tested; a convenient check is kept on the operation by lighting jets both of the unstripped and the stripped gas; the former gives a luminous, the latter a blue non-luminous flame, and rough photometer estimates can be made. During the scrubbing period the container jacket G, which is provided with a gage H and a drain cock J, is charged with cold water. Gas is passed through the scrubber at the rate of 5 cubic feet per hour, and the 100 cubic feet needed for an experiment will thus be dealt with in about twenty hours. The absorption period completed, the cocks E and D are closed, K is opened, and the water-level in the jacket is lowered through J to about one-third. The ring-burner R,

which heats the jacket, is now lighted and steam is raised in G, the excess of steam escaping into a condenser O. When the water is well boiling, K is shut, while M and N are opened, and the small burner S under the superheater coil L is lighted. The steam then passes from the jacket through L and M into the container and up through the material, escaping together with the vapors liberated through N into the condenser, which is cooled by water entering at P and overflowing at Q.

The charging hole T on the top of the container is closed by a screw cap; the drain cock F removes water condensing in the apparatus and any surplus oil. The distillation is continued until the absorbed naphthalene has been distilled over; this takes about an hour. The distillate obtained, amounting to 100 or 200 cubic cm., is separated from the water and further examined by any convenient method of fractionation or chemical analysis, etc.

We stated already that this apparatus has also been found very convenient for controlling washing operations in works laboratories, and it is being made for this purpose by Messrs. Alexander Wright and Company. The best, long-known method available for such purposes, freezing out condensable hydrocarbons and fractional distillation, has been amplified recently and taken up by the Bureau of Mines and others, as we mentioned on previous occasions. But these methods are more suited for research and require skilled manipulators, and there is another aspect to this matter, to which Dr. Lessing referred. At present gas undertakings supplied a more or less considerable percentage of inert gases (nitrogen and carbon dioxide) with their product, and that dead-weight had to be compensated for by enriching the gas with compounds of higher calorific and illuminating values. By studying the compounds of this kind "naturally" present in the gas when leaving the retort or the superheater (in the case of water gas) it should be ascertained which of these compounds were economically the most and the least important, and it would probably pay to extract the gas exhaustively and to either incorporate with it hydrocarbons of lower value for other purposes, or else to replace part of the extract by cheaper grade petroleum distillates or cracked spirits. Signs were not wanting, however, that a gas free of inert gases might, in the near future, be obtained from coal. The demand for further analyses and a further study of the mechanism of carbonization and after-treatment of the gas was thus becoming more urgent, and even now a detailed examination was essential, for which ready methods were hardly available.



Experimental apparatus for extracting benzol

to the steam temperature. The steam carried the vapor over into a condenser and a receiver, fitted with overflow pipes for crude benzol and for water respectively. Three such stills were combined for scrubbing, steaming and cooling in rotation. The labor involved was restricted to manipulating the valves and collecting the distillates; there were no pumps or moving parts, steaming was not required for more than short periods once every twenty-four hours or more, and little floor space was taken up by the plant. In the ordinary scrubbers any thickening of the oil was a disadvantage, as the increased viscosity prevented contact between vapors and fresh absorbent. When the oil was absorbed by porous bricks the thickening of the thin film by the

\*Engineering.



A cripple, with but one arm and one eye, cleaning teeth



How the patient assists the crippled dental nurse

## The Conservation of the World's Teeth\*

### A New Occupation for the Crippled Soldier

By Frank B. Gilbreth—Mem. Amer. Soc. M.E.; Member Franklin Institute; Past Vice-President of the Society for the Promotion of Engineering Education—and Lillian Moller Gilbreth, Ph.D.

This paper embodies a new aspect of the crippled soldier problem, that of finding work that needs to be done and has not been done, or has been done inadequately, and assigning it to cripples.

In this age of destruction there is great need of conservation, and no conservation is so necessary as that of human beings. With the constant destruction of men in the great war has come the pressing need of conserving and using the cripples, both war cripples and industrial cripples. This is necessary for the good of the maimed themselves, as well as for the good of the world.

We may place the cripple by so changing his old work, by means of motion study, as to enable him to return to it. In many cases this is the best method to use, as it helps the man to "fit back" into normal life, and demands little reeducation<sup>1</sup>. Or we may place the cripple by so changing a type of work that he has never done as to make it easy and possible for him to earn a living. An example of this is the work made possible by so adapting the typewriter and other office devices as to allow a man of intelligence who has never operated them to earn a living and compete successfully with uninjured workers.<sup>2</sup> This is an excellent method where the cripple desires a new occupation and a new interest, or where the old occupation, because of its lack of adaptability, or because of the nature of the maiming, has become unsuitable or impossible.

Or, again, we may place a cripple at some new work, such as dental nursing, that has never been done to the degree needed, that is practically a new and a much needed occupation, and thus not only employ him, but also conserve the energy of those he tends as well.

Dental nursing may be defined as that part of prophylactic treatment of the teeth that can be done by a person without a complete dental training, namely, the polishing of the teeth by hand with stick and pumice.

There is a world-wide lack of knowledge as to the relation of sound teeth to good health. America is recognized as the leader in the profession of dentistry. American dentists are recognized throughout the world as being, as a class, the most expert practitioners in all branches of dentistry, the other countries are now also coming to the front in this great humane work. In spite of the great work of the dentist, even here in America and still more abroad, the care of the teeth is generally looked upon too often by the public as simply concerning appearance, beauty and comfort or speed in the process of mastication, rather than as the most important factor of good health, while the dentist is too often interested primarily in filling cavities rather than preserving the tooth as a whole. The greater productive efficiency resulting from the natural use of all of one's

teeth remains almost unappreciated. It is natural, this being the general viewpoint, that care of the teeth, or dental treatment, is often classed as a luxury rather than a necessity. The high cost of dentistry practically makes such treatment a luxury at present.

We find, then, that the average person

1. Does not appreciate the importance of the by-products resulting from sound, clean teeth.
2. Does not realize that it is physically possible for nearly all to have sound, clean teeth.
3. Does not know that the only reason that he has not good natural teeth is because of the present financial problem of high cost of "upkeep."

To be sure, there are dental clinics in all dental schools where one can get dental work done by dental students at a nominal fee, sometimes for merely the cost of the materials and in some cases for no charge whatever. But this is often extremely unsatisfactory, especially if the patients are workers who must lose their working time to attend clinics and secure treatment.

The work of the dentist is expensive, and must necessarily be. The high cost of dentistry is not surprising, nor is the profession of dentistry to be blamed for it. The training for the profession is long, arduous and expensive, and much of the work involves costly materials, as well as time, and provides problems requiring no end of education, experience and the highest grade of skill. Dentistry provides an unlimited, satisfying field for the mechanical genius. How are we to provide proper pay for such work, yet insure necessary treatment to the average wage earner?

The answer to this is:

1. By functionalizing the work of the dentist.
2. By having the trained expert do the skilled work only.
3. By training low-priced workers to do such parts of the work as require less skill.

The results of the functionalization will be

1. Reduction of the cost of the cleaning of teeth.
2. Clean, which means sound, or "near sound," teeth within the reach of all.
3. Less need of costly work by the man unable to afford it.
4. Savings that can be devoted to such work, if it be needed.
5. Better health and added efficiency.
6. New work for the dental nurses, the cleaners of teeth.

There are several questions involved that must be answered. The first is: Do clean teeth last longer than those not clean? It has been proved time and time again that teeth can be preserved by preventive treatment. This is recognized today by all of the best dentists. Nearly all teeth are lost in two ways:

- A. The teeth decay.
- B. The teeth become loose.

Both decay and loosening can be almost entirely eliminated by frequent cleaning with a tooth brush, with dental floss, and treatment by a thorough process such as by the stick and pumice of the operator. It is difficult to get most children and many adults to use a tooth-brush habitually, but it is always easier to induce one with good teeth to use a brush regularly than one with poor teeth. Besides the daily cleaning it is desirable also to have frequent cleaning by a dentist, but the dentist cannot afford to give his time to do this cleaning at a price the worker can afford to pay. The result is that the great majority of people have their teeth cleaned by a dentist at periods rather more or less than a year apart.

Careful records of teeth that have been cleaned by a dentist once a month regularly for a long period of years show beyond the slightest doubt that the number of cavities that occur are very few, and that these can be filled, while of small size, with little injury to the teeth and with little or no pain or discomfort to the patient. The bacteria that cause decay adhere to the surface of the teeth, then cover themselves with a film that is jellylike at first, and, if not soon removed, becomes a hard covering, under which the bacteria proceed safely to attack the tooth. "Decay" follows. Scrape the bacteria off before they attack the tooth and there is no decay.

The second question is, "Can the work of the dentist be functionalized as suggested?" All work can be functionalized, and most kinds of work are being. The work of the dentist is already functionalized much more than it was a few years ago, and is being divided more and more every year. For example, the dentist makes few of his tools nowadays, and dental laboratories are doing more and more of the mechanical work of the dentist. The laboratory specialists can do the work better than the "all round" dentist, and can do it for him at a price at which he cannot afford to compete. In other words, the dentist, under the financial incentive, sublets certain work that relieves him of certain low-priced motions. Such are involved in the preventive operation of cleaning the teeth.

The third question is, "Can the dentist afford to give up this branch of his work?" There will be some objection from some quarters to this suggestion. Some will say that "the dentist needs the money." This is offset by the argument "the patient needs the teeth." "Our natural teeth belong to us and we must decide."

Seriously, this new work will bring more, rather than less, work to the dentist. The barbers were aroused when they saw the rapid increase in the popularity of the safety razor. Yet the barber was never so prosperous as he is today. Shaving was a luxury in the days of Benjamin Franklin. It is now almost a daily necessity for most men. The care of the teeth at a price that all workers can pay will eventually make more work of that type for which their training fits them for the dentists. Those dentists whom we have consulted agree to this.

\*Presented at the Conference of the Society for the Promotion of Occupational Therapy, March, 1917.

<sup>1</sup>"Motion Study for Crippled Soldiers," American Society of Mechanical Engineers, 1916.

<sup>2</sup>"How to put the Crippled Soldier on the Payroll," Economic Psychology Association, 1917.

The fourth question is, "Will assigning this preventive work to others than dentists spread disease?" To teach dental nurses the principles of antiseptics is a comparatively easy matter. Moreover, they should be allowed to practice only after passing a proper examination, proving their ability, and then receiving a proper license. A complete "follow up" system, such as is outlined by Dr. E. A. Codman of Boston for hospitals, should be installed, whereby each treatment should be recorded, and the records sent to the State Department in control of the work. This follow up system, called the "End Result Record System" provides for making records of the patients and the treatment at the time of an operation, and requesting each patient, by letter, to report his condition one year after. Patients will not have the same objection to the recording of all particulars of dental treatment that they have in the case of medical treatments. Such a follow up system "over-inspected" by the State Board of control would very materially increase the quality of the general practice of dentistry.

This paper is not on the subject of dentistry except in so far as it discusses this separation of the function of cleaning for the prevention of decay. Nevertheless, the general principle, that inspection always causes an increase in quality, should be emphasized.

The fifth question is, "Would it not be extremely difficult if not impossible to teach the dental nurses the best method of doing their work?" In our work of installing management in the industries we have found that problems that have always been considered very difficult become comparatively easy of accomplishment when the methods of the best workers have been recorded by the micromotion and chronocyclegraph methods, then analyzed, minutely measured, synthesized and standardized. We have found that the method of least waste never lies in the consecutive acts of any one worker. We have invariably found that a better method can always be devised than has been found already in existence. This can be realized in the case of the dentists, particularly because of the fact, that being "lone workers" they have comparatively little chance to watch and to learn from each other, as do the workers in an office, shop or engineering undertaking, or other groups. Recording the methods of "lone workers" always brings out the fact prominently that no two operators use the same method. Obviously their methods cannot all be the best. Our studies of the dentists who have cooperated with us bring out this general fact with surprising force.

Now, teaching the one best method known and presenting the method by means of standard instruction cards, stereoscopic photographs, chronocyclegraph, simultaneous motion cycle charts, motion models and our other devices and methods for the transference of the best experience and skill from those who have it, to those who have not, gives the learner at once, at the very beginning of his career, the knowledge of the best method known. This best method is based upon the actual measurement of motion study, and not upon the personal opinion or judgment of unmeasured experience. This does not mean that the worker so taught cannot deviate as his judgment later may dictate. He may deviate later for greater efficiency, and, on the other hand, he may deviate downwards, but at least he will be first taught and will learn that best method known, and will always feel the call and the constant interference of his habits first learned, and these are the best that can be found. This method of deriving and teaching the "best way" should be used by the dental nurse, and we are prepared to furnish at cost to teachers of cripples, standard micromotion studies of a one-armed, one-eyed, legless dentist cleaning teeth with most satisfactory results.

The sixth question is, "Would not the equipment for doing the work be so expensive as to prohibit many undertaking the work?" There is much work in the prevention of decay that can be done with almost no expense for equipment. This is vital to many patients, for, in the last analysis, they pay for the equipment, whether good or bad, whether expensive or inexpensive. If quite expensive, it is not apt to be easily portable, and they must pay also with their time in going and returning to and from the place where the non-portable apparatus and equipment is located. If portable, they may have to spend more time in the cleaning process. This, however, may be of still less importance if done outside of their working hours. A stick of wood, orange wood, is particularly satisfactory, but many other kinds of wood are suitable, and a little powdered pumice will do remarkable preventive work in the hand of a properly taught dental nurse.<sup>1</sup> If a stick be used, the same stick should never be used on two patients. The stick should be thrown away, after it has been once used.

<sup>1</sup>We are indebted to Mr. George W. Dickerman for particularly efficient devices for this purpose.

The pumice, once poured into the dish, should never be used again, that is, only enough powdered pumice should be poured from the bottle to serve for one treatment of one patient. The dental nurse should always wash his hands thoroughly with good soap and hot water, in the presence of the patient, both before and after, a cleansing treatment; particular attention being given to the crevices around and under the nails. An expensive dental chair is, of course, more comfortable but it is not at all necessary. It is better to perform the process on a log in the forest, on a mason's scaffold, on the front door step, or in a barber's chair than not to do it at all.

This leads to the seventh question. "How can the people be induced to avail themselves of this service?" First, by making it fashionable, and by making it economically and hygienically indecent, not to have teeth cleaned. Preventable loss of teeth must be made the badge of ignorance, personal neglect and indifference to national efficiency. Second, by holding parents criminally responsible for the condition of their children's teeth until the children are old enough to be responsible for caring for their own. Cavities found in children's teeth should be reported, and a follow up system carried out, making neglect to have a cavity filled sufficient cause for a visit from a dental inspector, similar to a truant officer, who would inspect and enforce the proper cleaning and thorough filling of all teeth. This may seem radical but the far-reaching ill effects of inefficient teeth are important enough to warrant it.

If statistics could be made of the loss of productive efficiency, to say nothing of the agony and loss of working time due to defective teeth, they would show the necessity of radical treatment of this important subject. The reason that but little has been done about the nation's teeth is because the possibilities of the subject are comparatively little realized, and the most necessary innovations have always come surprisingly slow. The majority of people as yet do not realize the actual money value of their teeth. It is safe to say that every dollar saved on teeth at present is given several times over to a physician later, and the general cause of much ill health is traceable to the bad condition or absence of the teeth. Furthermore, few people know that most of the decay is easily preventable by proper periodical cleaning, and the rest of it can be taken care of by the filling of the cavities when they are first formed. A very large proportion of the people get their first knowledge of a cavity only when it is large enough to ache.

The eighth question is "Exactly how can this new work benefit the crippled soldier?" In our motion study investigations of the most skilled dentists who are cooperating with us, we find that the work of prevention of the loss of teeth can be done by an operator who has but one hand and no legs. Of course, it will be generally admitted that an operator will never be expected to do much of the operation with his feet. Nevertheless, most dentists stand when they are doing such work. It can be done quite as well sitting, and legs are not in the least necessary for the work. While a dentist uses both hands with his work, the patient's hands usually remain idle. Now, we find the patient can pull his own lips to one side perfectly well, and even hold the little mirror if necessary, though this is seldom if ever actually essential except for greater speed and subsequent inspection. We make this statement after having had dentists actually do the work to their satisfaction, with one hand held behind their backs during the entire operation.

Thus this new and necessary work may be used to provide a livelihood for the maimed heroes of all countries who are being discarded by the great war. The livelihood will be better than most of them made before they were crippled, and the vocation will provide a most pleasant outlook that will assist in hastening the rapid recovery of many a man who sees that his disability will prevent his following his previous life work. We believe that a totally deaf, one-eyed, one-handed, legless cripple properly taught can do more efficient work in cleaning than the dentist can do in the time for which the average worker can afford to pay. This is no dream for the future. It is a working plan which is being carried out today. The most progressive and skilled dentists whom we can find have consented to cooperate with us, all without pay, and will furnish the standardized instructions, derived by means of the methods of measurement of motion study. We are being advised by dentists who have had large European experience and are, consequently, thoroughly familiar with European conditions. We desire to thank them here, and especially to express our appreciation of the cooperation of Dr. J. G. Bunker and Dr. F. L. Marshall for assisting in making motion studies. The data derived from such studies will, by means of the simultaneous motion cycle charts, be adapted to the use of the maimed workers, and the instruction of such workers will be immediately begun. Dental nursing will then provide a new vocation, and at the same time provide for supplying a community need. It will take

no work from those who need it. Rather it will relieve an over-worked profession of low-priced and low-skilled work. Moreover, being based, as it is, on motion study and fatigue study it will supply at the same time occupation and interest, those fundamental needs of the crippled in all countries and all times.

### Ancient Distribution of the Labrador Eskimo

WHEN first discovered by the French, the Eskimo inhabited the north shore of the Gulf of St. Lawrence as far west as Mingan. They were driven from this locality at the beginning of the seventeenth century by the Montagnais Indians, who had been supplied with firearms by the French. They retreated northeastward to the Strait of Belle Isle, where they maintained themselves until about 1760 in a fortified camp on an island near the western end. Here they were again attacked and completely routed by overpowering numbers of French and Indians. Tradition places this last battle at Battle Harbor, and gives the number of Eskimo slain as a thousand souls, which is probably an exaggeration.

The Eskimo were at a distinct disadvantage in the fighting on land, as the Indians were in larger numbers and possessed superior weapons. But it is said that once the Eskimo could draw them away from the coast, the condition was reversed. The story still lingers in the vicinity that it was the practice of the Eskimo to lure bands of the Indians to the islands adjacent to the coast, by a single kayaker acting as a decoy, where the main body would descend on them when the Indians were off their guard, take possession of their canoes, and massacre the whole outfit. A certain island on the Labrador coast is said to take its name of Massacre Island from such an occasion.

After their defeat on the south coast, the Eskimo retreated northward and established themselves at Hamilton Inlet, then called Ivuktoke or Eskimo Bay. A few stragglers remained in Sandwich Bay, the next inlet south of Hamilton Inlet. Some authorities are of the opinion that the Labrador Eskimo never settled permanently farther south than Hamilton Inlet, and that the large bands encountered by early French and English explorers were summer voyagers from the north. It is true that after this date the Eskimo descended into the strait from their strongholds in the north, but it would appear that the presence of fortified settlements, camps, and burying grounds south of Hamilton Inlet, as well as archeological material extending as far south as the state of New York, were evidence of at least a scattered population. The Eskimo rarely inhabit a border country in heavy numbers, but prefer a screen of hunting territory between themselves and their inveterate enemies, the Indians, over which small bands wander with caution. This is true of northern Alaska, the Mackenzie and Coppermine districts, Hudson Bay, and Labrador as well. So we may judge from the former numerous appearances of Eskimo in this district, and a few still surviving representatives, as well as the very apparent mixture of Eskimo blood in many of the resident whites of southern Labrador, that the Eskimo in small roving bands, formerly inhabited the coast south of Hamilton Inlet and part way down the Gulf of St. Lawrence.

There is also a tradition in this region that the Eskimo were accustomed to visit the northern coast of Newfoundland yearly, where they used to trade with the Beothuks. It is improbable that they would make the trip to Newfoundland from the country north of Hamilton Inlet in their skin boats under the ice and weather conditions which prevail on the Atlantic coast of Labrador; but in favorable weather it would have been quite easy to have crossed the Strait of Belle Isle from the southern camps.

Lieutenant Curtis, who made a careful census of the Eskimo on the Atlantic coast of Labrador in 1773, fortunately gave the old tribal names, one of which was recognized by one of my informants as that applied to Belle Isle. These tribal names are as follows: "from the Straits of Belle Isle going north the first tribes were known as:

The Ogbuette (Belle Isle).....	270 persons
The Nanyoki (Nain?).....	100 persons
The Kunedloke (Okkak?).....	360 persons
The Nepawiktoot (between Okkak and Hebron)....	70 persons
The Cannuklookthuk (Hebron).....	345 persons
The Chuckbuck (Saglek Bay?).....	140 persons
The Chucklelut (Lamson Bay).....	40 persons
The Noolaktuktoke (Ramah).....	30 persons
The Nuchvak (Nachvak).....	60 persons
From Nuchvak north into Ungava Bay.....	210 persons
	1,025 persons

This list is the only one which gives us any idea of the old tribal divisions on the Labrador coast. After the establishment of the Moravian missions, the Eskimo were gathered around these stations and the old tribal divisions broken up.—*Geological Survey, Canada, Anthropological Series, No. 14, by E. W. Hawkes.*

# Commercializing a Cuban Jungle\*

## Creating a Sugar Plantation in a Virgin Forest

By P. Shive

THE transformation of 10,000 acres of Central Cuba from a tropical jungle, heavily timbered with valuable woods, into a well-arranged system of sugar producing cane fields, separated by roadways and fireguards that not only lead to the centrally-located sugar mill but run parallel and at right angles to the prevailing winds, is a development interesting primarily to the engineer as a pathfinder for great industries.

A cane field, like everything else, must have a beginning and this beginning resembles the finished product about as a thick leaved rubber tree resembles the plant butt end of a pencil. The site of the cane field, as it is first seen, is a huge block of woods, heavily timbered with three or four creeks winding about over its comparatively level area. This big tract of timber, picked because of its fertility and valuable lumber trees, has been marked and cut out of a large plantation by the engineer whose camp is at the edge of the jungle.

The first problem is to fell the timber, and at the beginning of the five-month dry season the first arrivals on the scene of action are the clearing contractors. These men, sometimes a dozen in a gang, are at once assigned blocks of from ten to a hundred acres; they are shown their boundaries and start chopping at once. The boss of the gang, with a couple of helpers, slashes a trail, well into the heart of his tract and after picking a desirable camp location clears the underbrush, small saplings, and vines, picks a half dozen conveniently arranged trees for the corner posts of his shack, and starts his axemen to chopping for an acre of clearing.

To get rid of the underbrush, vines and small saplings, a dozen men are sent in armed with machetes, or long, blunt-pointed, keen-edged knives, two feet long with six-inch bone handles. These macheteros slash down vines and clear all underbrush as low as to the height of a man's knee, in order that the axmen may have a clear swing with his axe in cutting the trees. A dozen macheteros, scattered along a 100-foot front, make rapid headway. They will clear sometimes 50 acres in a day's work.

Behind the macheteros come the axemen, a line of them extending over the entire length of the clearing with intervals between to safeguard one axeman from his neighbor's falling tree. As fast as an axeman drops a tree he climbs up the trunk and lops off the branches so that no limb or sapling stands higher than ten feet from the ground. In this manner a man on horseback is enabled to see over practically the whole clearing and a good burn is assured. When an axeman strikes a valuable tree, such as hardwood, jiqui, majagua, cedar, or mahogany, he cuts off all branches and clears the trunk so that it may conveniently be dragged out.

While the cutters are getting started out a fonda, or eating house, is being erected in a suitable place near the middle of the proposed clearing. Here a well-driller starts work at once. If there is no convenient road from the nearby-village one must be cut. The clearing of this road is contracted for at once, the engineer shoots a line through to the middle camp, and a rough driveway is soon cleared wide enough for two caretas, or two-wheeled bullock carts, to pass carrying food supplies, axes, tobacco and other necessities, to the long palm-thatched huts that serve the purposes of eating house, general store and sleeping shed.

After the cutters have made a fair start caretas begin to drift in. Each of these fellows drives from one to six yoke of bulls. Their duty is to thread their way through the maze of logs, tangled underbrush and fallen trees in search of hardwood. When a hardwood or cedar is found the caretero clears a rough trail to it, squares off the sides with an axe, tackles a logging chain about it and hauls it out of range of the fire that is to come. Great numbers of these logs are hauled out in this manner and represent a very important and valuable function of the clearing. The logs are piled in rough order on high ground where high water cannot reach them. In these log yards are seen thousands of feet of very valuable lumber; timbers of cedar, majagua, jiqui, mahogany, ebony and other hard woods varying from one to five feet in diameter.

When the clearing is completed, the trees all felled and all valuable timber removed, the next problem is to provide for the fire. In Cuba the dry season lasts only three months, one month has been spent in clearing, and within three and one-half months, before the rainy season opens, this huge brush pile must be burned to the bare ground. Owing to the size of many of the soft

wood trees in the clearing, or tumba, the fire cannot be started until the blistering tropical sun has been allowed to play undisturbed for three months on the freshly cut jungle. In the meantime the clearing is in a precarious condition. The Cuban country-man is an inveterate cigarette smoker, and a carelessly dropped match or cigarette butt, together with the ever-present sea breeze may start a fire that will eat up the dry wood and underbrush, and thus gut the clearing. When the premature fire goes through it leaves thousands of bare logs and sapling, which are still green, to be dragged together and subsequently burned with much expensive hard work. To guard against such premature burning, guards are sent to patrol the edges of the clearing day and night. If a road crosses the clearing a strip 20 feet wide on each side of it is cleared down to the bare ground. A fire guard is cleared around the whole clearing, and consists of a strip of 100 feet wide, from which every stump, log, leaf and blade of grass has been removed, and a strip 50 feet wide from which all other brush has been removed. These fire guards insure not only the clearing from outside fire, but also the surrounding timber land, cane fields or plantations, from the final burning of the clearing.

After three months have passed the owner of the clearing sends messengers to all his neighbors, informing them of his intention to burn on a certain day. On the day set, in response to these messengers, squads of men arrive and are posted on each edge of the clearing. If there is no wind to whip the fire into a raging furnace, and carry it beyond control, the men begin preparations at once. Mounted Rural Guards, the national policeman of Cuba, patrol the boundaries of the danger zone. Piles of fresh green brushy limbs are cut and placed where they can be snatched up and used to beat back a sudden fire in an undesirable quarter. Huge jugs of rum, diluted with water, are set on convenient stumps where thirsty half-suffocated fire fighters may snatch a fiery bracing swallow to make more endurable the roaring heat and suffocating smoke.

When all is ready a signal is given, in the form of a gunshot, and to those edges of clearing across which the breeze blows towards the forest—so that the flames may be made to fight their way against the wind—there the fire is first applied. Frequently a succession of revolver shots is faintly distinguished above the roar of the fire. These shots are a call for help to where the fire has spread beyond control to the forest or to a cane field. In answer a score of men are rushed to the scene to beat out the flames with green branches. Now and again a deer or wild dog, terror struck by the smell of smoke and the roar of flames, dashes out of the clearing and darts drunkenly past the watchers and into the forest. Where the fire is hottest and the danger greatest, the fighters must be relieved every few minutes. Even then they are frequently overcome by the heat and choking smoke and must be carried back into the fresh cool forest to be revived by pure air and hot rum.

The fire rages all day and far into the night, and so the guards must stay on the job until daylight when they are finally relieved. At sun-up the clearing has a desolate appearance. For thousands of yards spreads a blackness, shimmering under the sun's blaze. All that remains of last year's forest; of last month's sea of brush piles; of yesterday's all-consuming blaze—all that remains now is here and there an occasional smoking, half-burned log, a huge, gutted, soft-wood stump whose roots still smoulder, a pure white streak of ashes where the heart of an ebony tree burned, or a small, significant heap of bleaching bones.

A half-day of rest follows the burning, and then the men are again at work on the clearing. All those half-burned logs must be piled around the larger stumps, and the whole burned before the planting can be started. This final burning is the hardest work of all, since the men must stand on the baked, burnt ground while the heat from the fires and from the sun play upon them. While the logs are being burned the engineer returns, with a score of men, to cut up the clearing into eleven-acre fields separated by fire-guards, or guardarrallas. This work must be rapid and accurate, for the reason that within three days all of the brush and left over logs will have been burned, and hundreds of men will stand idle until the fields are marked.

The engineer has had men in the woods cutting poles and long slender saplings, since the day the fire was started. He now erects a 30-foot pole, tipped with a square yard of red calico, over the first of a line long

of stakes that he has already set along one whole side of the clearing. This red flag is a signal to the instrument-man, on the far side of the clearing, who at once sets his transit over a corresponding stake, sights on the flag, and lines in a smaller red flag at intervals of thousand feet. This line of flags represents one side of a series of fire-guards, or alley-ways, that run the length of the clearing. Sugar cane, like corn, has many apparently superfluous leaves, which begin to wither and dry up at the base of the stalk when it is a few months old. This dry stuff furnishes ready fuel for a possible fire that would sweep through the cane field and leave the bare cane, stripped of its foliage, and ruined for the growers' purpose. To prevent the spreading of such a fire the alley-ways are cleared between each field, and serve the double purpose of roadway and fire-guard.

As soon as the first guardarraya is marked off the contractor first clears it of logs, and then sends in axemen to knock out all stumps so that the seed-cane may be hauled and distributed to each field. While the axemen are clearing the fire-guards the planters are prepared to mark off the fields in rows. Small hemp rope, in 100-foot lengths, is first wrapped tightly around a tree-trunk and then wetted. This process stretches the rope and insures it against too much variation in length when used a measuring unit. After the rope has dried it is stretched between two trees and tags of red calico are tied on at intervals of six feet. Three of these 100-foot ropes are tied together to make one long measuring rope. A man is put at each end and in the middle of it, and the rope is laid down along the edge of a field. Four more men with broad, heavy, square-bladed hoes trot along the rope, from the center and from each end, and mark the ground below each red tag on the rope. When both sides of a field have been marked in this manner the markers, stretch their improvised chain between corresponding hoe-marks, on opposite sides of the field, and again the hoes begin their marking. A cane field is never plowed, and so all stumps that escape the fire are left to decay where they stand, yet in spite of these obstacles the rows of hoe-marks are true and straight as those of a machine-planted Iowa corn field.

Behind the row-markers comes another gang of men, armed with hoes, to dig holes ten inches square and five inches deep at each hoe-mark. While the holes are being dug cartloads of seed-cane are being hauled and distributed in piles over the fields. This seed-cane, in four-foot lengths, is covered over with fodder to shield it from the hot sun. A couple of men at each pile of cane are set to chopping up the stalks on square-topped stumps. Each stalk is chopped in two at the middle of alternate joints so that the pieces each have one full joint with half-joint on each side. The seed cane is now ready to be planted. A planter with a canvas bag strapped over one shoulder, loads up on the chopped cane and then trots along, dropping two pieces of cane into each hole left by the hoes. The planter is followed by a final gang of hoe-armed men who cover the cane in the holes, and the planting is finished.

### Finishing Concrete Road Surfaces

ACCORDING to the *Concrete Highway Magazine* an excellent method of finishing the surface of a concrete street consists of rolling the concrete with a light, hollow, sheet steel roller about six feet long and eight inches in diameter, in which are inserted wooden ends supporting an axle, to which a bail is attached carrying a long handle, by which the roller can be operated from the side of the road.

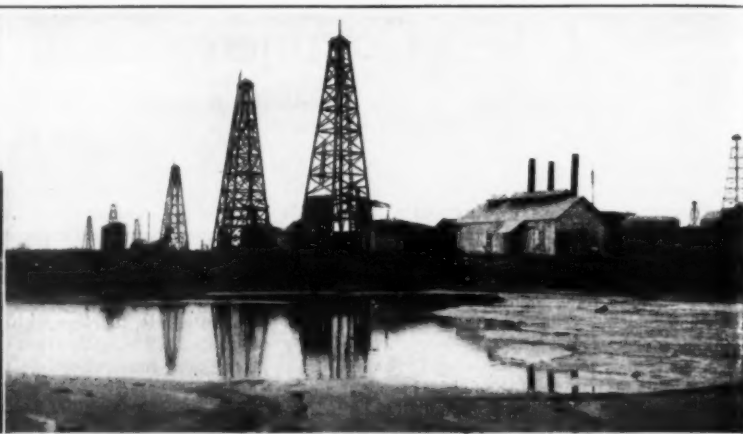
The manipulation of this roller is as follows: Immediately after the concrete has been struck, or placed, it is rolled by moving the roller transversely across the street or road. In case of an exceptionally wide street the handle is long enough to reach a little more than half way across the pavement. On a narrow street or ordinary country highway the handles will be long enough to enable the workman to roll the entire width of the road working from one side.

The effect of the roller is that of a rolling squeegee—it consolidates the top layer of the concrete and removes practically all of the surplus water. At the same time, it takes out the slight uneven places in the surface which may occur, particularly if the pavement has not been struck by a template. The rolling should be continued until free water ceases to come to the surface, when it is ready to be finished by the canvas belt. The effect of the belt is to give uniform, gritty texture to the surface.

\*The Iowa Engineer.



Oil wells in the Oklahoma oil fields



A lake formed by overflowing oil

## Oil Makes Millionaires

Fortunes Created by Eccentricities of Nature and War Prices

By O. R. Geyer

"Oil madness" has gripped the southwest as no other form of prosperity has done in the last two years of war-made millionaires. The southwest, or that part of it lying in and adjacent to the famous Mid-Continent oil fields, literally is rolling in oil and gold-oil, commanding a price of from four to five times the market of three years ago. As a result there has been ushered in a period of development and prospecting which has never been equaled in the history of the oil fields, for the southwestern oil district is making millionaires at such a dizzy rate that comparisons with other industries seems rather out of place.

Men who three or four years ago were in the down and out class are millionaires many times over today, while companies and corporations staggering on their last legs under a load of debt are bearing up bravely under a bank balance of prodigious proportions: Not since the first gusher was brought in in the Mid-Continent field years ago has the oil industry been in such a mad money making whirl. The boom days and frenzied prospecting that followed the first discovery of oil in the southwest have become as a memory compared to the developments of the last two years, so feverishly prosperous is the industry at the present time.

After a period of stagnation which had dampened the ardor of even the most farsighted and courageous oil producers and speculators, crude oil began a miraculous rise a little more than two years ago which has since placed it among the country's really select list of "war brides." The market began to ascend in jumps of ten cents at a time and continued to climb until it had reached the dizzy heights of \$2.00 a barrel. Some few sales were made at \$2.10 a barrel, but the genuine high-water mark was \$2.00. This was just five times the price crude oil commanded before it began to aviate toward the higher levels. Following this dizzy climb came a brief reaction, during which the market gradually declined until a low level of 90 cents a barrel was reached. This level was maintained for a few months and then began another advance which carried the Mid-Continent product to its present level of \$1.70 a barrel, which it has held for several months. What will happen in the future is only speculation, but there are a few wise producers who predict that the southwestern oil will command \$3 a barrel before many months.

The dollars and cents value of the present boom in oil circles is sufficiently large to engage the attention of experts who deal in figures of tens of millions or more. Leases which had become a liability three years ago and were being hawked about for a song, or were allowed to lapse, are being held for fabulous prices today. As an example, leases made in one Oklahoma county in recent months carried with them a bonus of \$1,000,000 to which will be added the royalties which will follow the opening of the new field. New fields are being brought in with such rapidity that the old time oil men are staggered. Huge armies of oil-field workers, teamsters, drillers, lease getters and other hangers-on, are spreading out into new fields as an army of ants invades virgin territory for the first time.

Nature seems to have caught the contagion of the times, and wells which could do no better than cough up a few barrels of oil a day in a feeble manner have been given new life and are making millionaires out of their owners. So many gushers have been brought in of late that all that seems necessary to tap some rich pool of oil

is to sink a hole in the ground and let nature do the rest. Discoveries of this sort have poured millions into the laps of the lucky producers.

As in nearly all other industries the grim hand of war has had an important part in producing this new-found prosperity. The shutting off of foreign production, together with the enormous demand for gasoline and other oils, which has grown up in America in the last three years, have brought about this present boom. Combined with these two elements is the fact that a natural decrease in the production of the great American oil fields has served to push the price of crude oil upward to unheard-of levels. Despite the frenzied prospecting of 1916, the production of the Oklahoma fields dropped off at the rate of 3,000,000 barrels during the early part of the year.

Oil men believe that the crude oil market will continue at or near its present level for some years to come, unless the demand for oil products is curtailed by the discovery of some new substitute in the way of fuel oil. The gradual decrease in production, they claim, is the surest sign of continued prosperity in the oil fields. Many of the old fields have been falling off in production for months, but, of course, this loss has been offset to a great extent by the discovery of new fields, and the bringing in of new wells.

The systematic, business-like search for other oil fields and pools which may lie hidden under the earth's surface is being continued over a wide stretch of southwest territory, from northeastern Kansas to southern Texas. This search has been carried into districts of the southwest which have been free from the designs of prospectors until the present time, and the Mid-Continent field is being enlarged to many times its original size. The wheat fields of western Oklahoma, which have been producing extremely profitable crops, have been invaded and farmers who have been growing rich through the medium of \$1.80 wheat are settling back to wait until the magic touch of oil begins to make new fortunes. One corporation acquired 9,600 acres of leases in one block in this section, in the heart of what geologists declare will some day soon be one of the best producing fields discovered in recent years. Leases several miles distant from the first test well sunk in this district commanded a bonus of \$35,000, with regular royalties assured the moment oil is discovered.

The development of this new territory is hampered somewhat by the shortage of materials and labor. Towns and cities in the district are simply unable to accommodate the great number of workers and hangers-on who have invaded the territory, and cities of tents are springing up overnight. As rapidly as rig supplies and other materials can be obtained, the sinking of new wells is being pushed, and the early predictions of the geologists have been verified by the output of the wells already brought in.

The present period of prosperity had its beginning in the fall of 1915, when crude oil began the remarkable climb from 40 cents to \$2.00 a barrel. The daily production in the Mid-Continent field averaged 300,000 barrels, which was somewhat less than the production in former months, but the advance in price posted throughout the district broke all records for money making, especially in the southwest. In May, 1915, the Mid-Continent was producing oil at the rate of 10,000,000 barrels a month, which was worth \$4,000,000 at the price of 40 cents a

barrel, which prevailed at that time. A year later the production had dropped 3,000,000 barrels for the month, but the 7,000,000 barrels were worth \$11,000,000, an increase in value of \$7,000,000 despite the smaller production.

The men who made money the easiest were those individuals and corporations who had stored away immense quantities of oil purchased at 40 cents a barrel. The unearned increment these individuals received amounted to tens of millions of dollars. On the first of January, 1916, there was approximately 115,000,000 barrels of crude oil in storage in Oklahoma. This was 3,000,000 barrels less than the entire production for the year 1915, which gives some idea of the immensity of oil stored away in the tank farms about the state. At 40 cents a barrel this oil had cost the purchasers \$45,000,000, but by the time the price had advanced to \$2.00 it was worth more than \$200,000,000. The pipe line companies were the chief beneficiaries, one, a Standard subsidiary having 40,000,000 barrels of cheap oil in storage. Another 30,000,000 barrels was held by producers and refiners classed as independents, while the Standard's holdings were equally large. One corporation, a relative of the Standard, realized \$45,000,000 in increased profits as the result of the miraculous advance, while the profits of individuals were increased from \$500,000 to \$10,000,000, depending upon the amount of oil the lucky persons had stored away in anticipation of such a boom.

The profits of the pipe line companies—there are four large corporations operating in the Oklahoma fields—were simply enormous. During 1915, these four companies carried 80,000,000 barrels of oil, an increase of 10,000,000 over the business for 1914. Had these companies charged their own refineries the same rate they demanded of the independents, their profits for the year would have been 41 per cent of the capital stock. As it was they earned 19 per cent on their investment, according to a report made following an investigation. The Prairie Oil and Gas Co., in particular, had a balance of \$35,000,000 on the right side of the ledger at the close of business on December 31st, 1915. Its profits for the year 1916 are said to have been almost as large.

More than 1,900 miles of new pipe lines were laid during the year to accommodate the increased business, and these improvements will be duplicated within the next year. There are at present 6,000 miles of pipe lines in the Oklahoma fields. This represents an investment of approximately \$25,000,000, which does not include numerous other millions invested in pumping stations which cost from \$200,000 to \$400,000. These stations are maintained from every twenty-five to fifty miles to force the oil through the pipes. This, however, represents but a small part of the money expended, or which will be expended in development work in the Mid-Continent field. Hundreds of new wells are being drilled, and scores of the huge 55,000 barrel tanks are being set up in new locations. The fact that the market promises to remain more or less stationary at the present level, is an incentive for even more active work in developing the new fields.

New towns arise overnight, the map of Oklahoma now being dotted with numerous oil towns which did not exist three years or even one year ago. What was formerly a cotton field near the famous Cushing field became a city of 5,000 almost overnight. Thousands of oil field laborers settled down to make their homes in the newly laid out



An oil pumping station



A pipe line junction

city, which was given the appropriate name of Oilton. Four thousand teamsters were engaged a few months later in hauling supplies out into the surrounding fields from this one town, enormous quantities of supplies and materials being received every month. More than 4,000 cars were required to haul the steel used in erecting 55,000 barrel tanks alone, lumber and other supplies filling thousands of freight cars. In all respects Oilton is the town that oil built.

The stellar event of a year which was marked with pyrotechnics such as were never witnessed before, was the bringing in of the world's most famous oil well in the Cushing field. The day it was brought in, the well gave no evidence of being anything more than an unusually prolific well, producing about 3,000 barrels a day. Then it began to climb and at the end of ten days was flowing at the rate of 20,000 barrels a day. From that time it began a gradual decline until it reached 10,000 barrels a day, which mark it held for some time. Even weeks afterward it was still the most prolific well in the Mid-Continent. Its discovery came just at the time crude oil reached the crest, and a half-owner of the property disposed of his 100,000 barrels of oil, one-half of the receipts for the first twenty days, for \$200,000. This sensation brought about frenzied prospecting on the part of thousands of other oil men, frantic efforts being made to tap the same pool which was making a fortune for the owners of the big well. Even river beds were not sacred in this mad rush, nearly a score of producing wells being bought in the bed of one of the largest rivers in the territory.

Recent transactions in the southwest field indicate the magnitude of the business being conducted during the present era of prosperity. During the first week of the year Robert McFarlin added \$35,000,000 to his already large fortune by the sale of a part of his holdings in the Mid-Continent, becoming thereby the richest oil man in the southwest. On the other hand, the Sinclair Company, a newly organized independent concern, which has been buying up small independent holdings in order that it may become the largest of the independents, is spending \$10,000,000 in improvements. The entire district is saturated with this spirit, and there seems no end to the period of prosperity which is said to be making millionaires at the rate of one a day. Should crude oil maintain its present level in the market, Oklahoma will have firmly established its reputation as being the newest hotbed of millionaires.

While the field has been gripped by the deadly "oil madness" the wild speculations and investments of former boom days are being leavened somewhat by scientific management. The practical side of the industry which heretofore has been looked upon as the biggest gamble with nature, is being developed to such an extent that blind prospecting is about at an end, save for the small-fry hanging on to the tail of the big financial comet. Waste of crude oil and gas, which has been allowed in a most reckless manner, is being brought to an end, under government and state supervision, and the operator who permits needless waste of oil products is subjected to a daily fine for every day a fire is allowed to burn or a well is allowed to flow without being controlled and the oil saved.

An interesting phase of the newest boom has been the recognition given geology in the last two or three years. Five years ago the scientist who declared that he could locate oil by examining the rocks was laughed to scorn, but today that individual, providing he has more than the rudimentary principles of his profession, is a most sought-after individual. His word is law today, large companies risking millions upon the reports of their staffs of geologists, without going to the trouble to sink a well to verify them. One of the largest

companies in the state has a staff of forty geologists, whose salaries and earnings are so large that the president of the corporation is moved to tears every time he thinks of the outgoing money. But this doesn't mean that he is anxious to get rid of the geologists on the pay roll, for they are perhaps the most important asset the company has, aside from its physical property.

One Oklahoma corporation thought so well of its chief geologist that it invested \$1,000,000 in a lease on which a well had never been drilled. Every company of importance is "playing geology," in the language of the field, and is growing rich thereby. No well-established company ever dreams of buying a property without sending a geologist to study the "structure" and report on the prospects for continued production. Once a member of the staff has reported favorably, the corporation is willing to go the limit in acquiring the property. No lease is ever offered for sale without the report of a geologist being appended or presented at the beginning of negotiations. Unless the would-be seller can show such a report his efforts to gain a hearing with a big corporation are likely to be in vain. But if a geologist has "O.K'd" his property, almost any company is willing to pay the price demanded without quibbling.

The fees of the leading geologists now employed in the oil field work run into the thousands of dollars. In fact, the earnings of some run well up into six figures. There is the case of Vandruff & Vandruff, father and son, who came into the Oklahoma fields several years ago on a mission of investigation. They were employed by an important independent company to investigate the "structures" in a large area of wild and unsettled mountainous country at some distance from the proven fields. Oil men laughed at them, but the Vandruffs spent several weeks in a country inhabited by wild animals and wild Indians, making a close survey of rock "structures." When they reported, lease men were sent into the country to take up all the property approved by the geologists, who were given a one-eighth interest in the leases as their fee. A few weeks later, when the first wells were brought in, they sold out for \$500,000, which is perhaps the largest fee ever received by a geologist. While not all of these men are receiving such enormous sums, their earnings are large enough to warrant the attention of income tax collectors, and still the field wants more geologists.

#### Measuring Starlight by Selenium

In a recent number of *Scientia*, Mr. Fournier d'Albe discusses the properties of selenium and emphasizes its value for delicate work in stellar photometry. *La Revue Scientifique* (Paris) gives the following summary of the article:

It is a well-known fact that the conductivity of selenium increases under the influence of light. For feeble illuminations the laws of the phenomenon are as follows:

a The conductivity conferred by a prolonged exposure to the light is proportional to the square root of the illumination (in other words it is inversely proportional to the distance between the selenium and the source of light.)

b The conductivity conferred temporarily by an instantaneous exposure to the light is proportional to the incident energy.

With an electromotive force of one volt, an illumination of 1,000 lux (1,000 candles at one meter) enables us to obtain a current of one milliamperes per square centimeter of the sensitive surface. For feeble illuminations the utilisable effect is comparatively greater, because of the law of the square root. Thus we will reduce the current of one milliamperes only to  $\frac{1}{10}$  of a milliamperes in reducing the illumination to the ten-

thousandth part of the value above indicated, that is,  $\frac{1}{10}$  lux.

This gives us a possible application to the measurement of very feeble illuminations, such as those we find in stellar photometry.

Let us suppose that we utilize an electro-motive force of 10 volts upon a selenium cell having a surface of 100 square centimeters. With 1,000 lux the current would be 1 ampere. But it is possible to detect a current of less than  $10^{-12}$  ampere, and the measurement of a current of  $10^{-10}$  ampere is a common operation in physical laboratories. If, therefore, the law of the square root is valid for all illuminations we can reduce the illumination to  $10^{-20}$  of the value indicated above, and still obtain a measurable effect. This would give us an illumination of  $10^{-17}$  lux, which represents a star of the 28th magnitude; i. e., a star which is really too distant to be distinguished by the most powerful telescope which has ever been constructed.

There is, however, a difficulty inherent in the preceding experiment, that is, the time necessary to produce the effect. It would be necessary to prolong the exposure to such a feeble light for several days before obtaining the final current, and it would be impossible to maintain the other conditions constant during so long a time.

But we can put in operation the law of instantaneous action and subject the selenium to an exposure of one second. This does not make any considerable change in the current from which we start, with an illumination of 1,000 lux, and we may permit the current to be of one ampere, for the action is very rapid in the case of a bright light. Reducing this illumination to  $10^{-10}$  of its primitive value, we obtain a current of  $10^{-10}$  ampere with an instantaneous illumination of  $10^{-7}$  lux, and an illumination of  $10^{-12}$  ampere with an illumination of  $10^{-9}$  lux. The first of these illuminations represents a star of the 8th or 9th magnitude, and the second a star of the 13th or 14th magnitude. These stars are completely invisible to the naked eye.

Thus a surface of selenium of 100 square centimeters will detect a star invisible to the naked eye. By reducing this surface until it is no larger than that of the pupil, the limit up to which it will reveal a star electrically will be constituted approximately by a star of the sixth magnitude; this limit is very nearly the same as that for the eye. By improving the method of measuring currents and increasing the sensitiveness up to  $10^{-14}$  and  $10^{-15}$  ampere the selenium will have a decided advantage over the eye. We may hope to discover by the use of selenium, many hitherto unsuspected details of the structure of the heavens.

Moreover, a certain number of interesting results have already been obtained in this way. This is the way the American astronomer, Stebbins, carefully studying the curve of the light of Algol by means of a selenium cell placed at the principal focus of a lens of 30 centimeters aperture, has been able to prove the existence of a feeble luminosity belonging to the obscure satellite of Algol.

#### A Gas Pressure Reducer

It often happens that the gas supply in the mains is at a too high pressure to be used with economy in gas stoves, and in any case there is danger of using considerably more gas than is really needed, so that a device for reducing the pressure will prevent waste of gas in quite a number of cases. A simple device of this kind has one end connected by hose to the mains, while the gas comes out of the other end and goes by a second hose to the burner. Between the high and the low pressure sides is placed a partition containing a set of fine holes, so that the gas can only pass through at a reduced rate, and this is found to lower the pressure very effectively.

# Shipyard Cranes\*

## Details of Equipment Installed in Rotterdam

By M. G. De Gelder

ALTHOUGH several papers on shipyard cranes have been read before this Institution in previous years, I hope that the following description and particulars of shipyard cranes introduced by the Rotterdam Dockyard Company may be of some interest in connection with the development of hoisting appliances for shipbuilding purposes. The company was established in 1902, and in 1904 started on the New Waterway its repairing works, which included well-equipped engine and boiler shops, foundry, smithy, etc., adjacent to the ship-repairing sheds, and two private floating docks. In 1906 it was decided to build a sea-going steamer of 1,600 tons deadweight, and as the appliances for the building of new vessels have been steadily and rapidly improved during the intervening years, the Rotterdam Dockyard Company is now turning out more tonnage than any other shipbuilding yard in Holland. Originally the shipyard used the ordinary derrick-masts of modernized type (viz., latticework masts with electric hoisting winches on the ground level), and, in addition, wire-rope switchbacks between wooden poles placed at the ends of each berth. This combination of derrick-masts and switchback was found to be very satisfactory when account was taken of the low initial cost, but it was thought advisable to adopt a more efficient arrangement, because the size of steamers to be built was constantly growing, and quick handling of material was absolutely necessary in order to arrive at a large output with the limited number of workmen available in the Rotterdam port.

Various systems of shipyard cranes are already in use, and in the papers read on this subject interesting particulars have been published regarding them. In some of the larger British and German shipyards overhead cranes, very common in engineering and boiler works, have been adopted, combined with roofed building sheds, the cost of which may amount to £25,000 to £50,000 for each berth. It is doubtful whether such high initial cost will give an adequate return, but I think it would only be possible in exceptional cases, such as in the building of huge and expensive Atlantic liners, large battleships, etc. On the other hand, many British yards capable of efficient work with regard both to price and time of delivery are still adhering to the system of derrick-masts already referred to, and even now large battleships are being built by means of such hoisting appliances. In view of these facts shipbuilders are obliged to study the problem carefully before taking a decision as to the system of shipyard cranes to be fitted. Generally speaking, I have the impression that the necessity for the quick handling of material has often led to arrangements being adopted which are too expensive from an economical point of view, while, on the other hand, conservatism or want of capital has made several shipyards adhere too long to old-fashioned methods of building vessels as far as cranes are concerned.

It is, of course, rather difficult to design a satisfactory arrangement between the two extremes referred to. In this respect each shipbuilder should be guided by his own personal views or experience, by special requirements and local circumstances. As a rule, any modern arrangement of shipyard cranes will lead to wider spacing of the building berths than ordinary derrick-masts would require. It is often claimed as an important advantage of such derrick-masts fitted between the up-rights that they do not take up much space. It is doubtful, whether nowadays a large number of narrow-spaced berths really are an essential advantage. I rather think the time has passed when it was considered a wise policy to lay down the vessels as close as possible to each other, so as to get the maximum number of berths on a certain length of river frontage. The amount of money wasted owing to want of space is not always realized, for surely in modern industrial works plenty of clear ground means a good deal of saving. From an economical point of view it may be better to build eight steamers per year on three berths than to turn out the same number of vessels on four berths, laid down more closely on the same ground space. Therefore, even if the fitting of shipyard cranes requires a strip of ground to be left open between the berths, thereby reducing the number of berths possible over a certain river frontage, it does not follow that valuable ground is really lost.

It must be borne in mind that ship material cannot always be put in place immediately when ready for

erection. Every shipbuilder now tries to rivet mechanically on the ground as many floors, brackets, girders, bulkheads, etc., as possible to avoid the expense and delay due to riveting up after erection. Apart from this, on account of the laying-off system now adopted more and more in continental yards, large numbers of deck, shell and double-bottom plates, etc., are punched and machined before the keel of a vessel is actually laid. Under these circumstances large quantities of ready material have to be removed from the shops to somewhere in the yard near the building berth before being put up in position. To avoid shifting such material more than once, sufficient ground space must be available either in front of or between the berths. As it is always cheaper to transport material by trucks along the berth (on which it is already loaded) than by cranes over the top of the vessels, open ground space alongside the berth is certainly useful. On the other hand, ground space is kept available in most yards in front of the berths in anticipation of the building of larger ships in the future. Under these circumstances it seems advisable to design the shipyard cranes in such a manner that they can lift material as well from the ground in front as from alongside the ships, and so that they can deposit this material without further handling to the position where it is to be fitted.

In this respect derricks or masts, forming fixed electric tower cranes, as, for instance, those described by Mr. Piaggio in the Transactions in 1907, are quite unsatisfactory. Referring to the discussion on this paper, I simply wish to point out, firstly, that to avoid more than one lift of material when ready, it has to be transported at once in way of the crane over-reaching the part of the vessel where such material is to be fitted, which in practice may often cause much trouble; secondly, that if such cranes are used alternatively for two berths next to these cranes, the ground space which must be kept open between the two berths for the material referred to reduces the working radius of the cranes on one side by at least the width of this open ground space; thirdly, that several cranes overlapping each other are necessary to enable the cranes to bring the material to the part of the ship where it is required. For two berths for vessels of about 360 feet in length, four cranes with long jibs would have to be fitted, and as the price of each crane, when capable of lifting, for instance, three tons at the outer end of the arm, will cost at least £2,000, including foundation, an outlay of £8,000 would be required for such an arrangement, which would be still far from satisfactory.

Although such cranes have been fitted in several yards, the idea of adopting this principle, in our case, was rejected at once on account of the above considerations. Complete plans and estimates were, however, made for overhead traveling cranes not roofed over, running on top of steel structures, and covering not only the full width of the berth, but also 20 feet of ground space reserved for depositing material alongside the berth. On account of the great width of the cranes consequently required, and the excessive height necessary for the girders to enable the cranes to pass over the highest point of the vessel at any state of building, the cost of this arrangement was found to be much in excess of the cost of cranes as finally adopted, apart altogether from the fact that the overhead cranes did not appear to be more efficient.

The traveling cranes of the hammer type, viz., transportable tower cranes running alongside the berths as described in Mr. Murray's paper in the Transactions of 1906, were also considered, but found not quite suitable. In the first place, the berths of our shipyard are purposely made sloping over a distance of about 300 feet from the ordinary low-water level on the river side up to the ground level of the shop, which is above the highest spring tide, i. e., 13 feet above ordinary low water, so as to reduce the height of the keel blocks at the fore-end of the vessels building. On this sloping part the tower cranes could not travel safely if the rails were simply laid on the ground.

Apart from this, I rather fear that, although it is not impossible, it is always very troublesome in a shipyard, to keep the rails and the ground space sufficiently clear of obstructions for the safe running of such cranes, more especially if this ground space is used for depositing material, and if the cranes are handled from a cabin which is about 60 feet above the ground. Finally, the weight of such cranes, when of sufficient dimensions and capacity, is about 80 to 100 tons. The weights to be handled

by these cranes are mostly only one to two tons, and it is not economical to have such heavy cranes constantly running for shifting light material. It must also be expected that these cranes will in practice never travel along the berths with the speed they are designed for, as already pointed out by Mr. Saxton White, when discussing Mr. Murray's paper. In this respect the cantilever cranes also mentioned by Mr. Murray, and more fully described in Mr. Fairburn's paper in the Transactions of 1902, are more satisfactory; but it must be a serious disadvantage of this system, much favored in America, that the loads can only be shifted either in a longitudinal or a transverse direction, so that it is necessary to shift the entire crane for the slightest adjustment in the position of the material which has to be put in place. Besides, the weight of the crane is increased by the arm used for the adjoining berth without it being possible to use the two arms simultaneously.

The cranes supplied by the Haarlemsche Machinefabriek, of Haarlem, are of the all-round swinging type, and run alongside the berths on top of lattice girders supported by columns. The cranes can lift three tons at the extreme end of the arm, i. e., with a radius of 22 m. (72 ft.) from the center, 7½ tons with a radius of 9 m. (29 ft. 6 in.), and intermediate weights between these limits. These intermediate weights, for instance, 5 tons at a radius of 13.5 m. (44 ft. 3½ in.) are painted on the arms at the corresponding radius, and in the cabin of the operator a special ampere meter is placed marking the weight lifted (instead of the amperes used), so that the operator may notice at a glance whether it is safe to lift a certain load at the required radius. This safety check was considered necessary as ordinary shipyard men are often far out when estimating weights of certain material to be lifted. The cranes were tested with 10 per cent. overload. The hoisting speed is ½ m. (20 in.) per second for 3 tons, ¼ m. (13 in.) for 5 tons, and ¼ m. (10 in.) for a load of 7½ tons. The horizontal traveling speed is 1 m. (39 in.) per second, and the swinging of the crane through 360 deg. requires only 35 seconds. The traveling speed of the trolley on the arm is ½ m. (20 in.). The motors for hoisting, traveling horizontally, swinging and traversing of trolley are all designed for 440 volt continuous current, and have a capacity of 27 h. p., 15 h. p., 4 h. p. respectively.

The crane gage is 6.25 m. (21 ft.), and the weight of the unloaded crane, including ballast, is 34 tons, equal to 8.5 tons per wheel. The pressure of the wheels on the girders may, however, be considerably increased by the wind pressure on the cranes.

We have assumed that the cranes should be capable of working with a wind pressure not exceeding 50 kilos. per square meter (10 lbs. per square foot), as heavy storms would make it in any case impossible to use the cranes. Even with such a wind pressure it is not practicable to use cranes of any description, owing to the great danger with the material swinging about. The wheel pressures have been carefully calculated in various positions of the crane, with the maximum load combined with wind pressure of 50 kilos. per square meter, and also in a certain position of the unloaded crane with a wind pressure of 200 kilos. per square meter, viz., 40 lbs. per square foot (the maximum which may possibly be expected). We found that in the most unfavorable position of the loaded crane, with a wind pressure of 50 kilos. per square meter, the pressure on the two wheels running on the same girder would be 11.5 and 17.6 tons respectively. When the wind pressure rises to 200 kilos. per square meter, the wheel pressure will be 17 tons on each of the two wheels, but in this case the cranes are always standing above the columns. The steel structure supplied by the Rotterdamsche Machinefabriek Braat, at Rotterdam, has been calculated to carry two cranes working as close to each other as possible, in any position between two columns under the most unfavorable circumstances, as referred to above. As long as the wind pressure does not exceed 50 kilos. per square meter, the two cranes can consequently lift in any position required a total weight of 6 tons with a radius of 22 m. (72 ft.), and at smaller radii weights up to 15 tons. The spacing of the columns has also been carefully considered, and it has been found that between certain limits the price of the structure was slightly affected merely by modifying the spacing. As, of course, it is advisable to avoid obstructions by fixed columns, a spacing of 27 m. (88 ft.) was finally chosen for the columns. For the smaller ships the length of the girders was consequently made 3×27=81 m. (266 ft.), plus two lengths

\*Read at meetings of the Institution of Naval Architects. (England).

of 5 m. (16 ft.), each projecting beyond the end columns, or 91 m. (298 ft.) in total, and for the larger ships  $5 \times 27 = 135$  m. (443 ft.) plus  $2 \times 5$  m. (16 ft.), or 145 m. (475 ft.) in all. Taking into account the length of the crane arms, when they extend beyond the ends of the girder path, there is a length respectively, of about 127 m. (418 ft.) and 181 m. (593 ft.) within reach of the cranes. The arms of 22 m. working radius project 19 m. (63 ft.) outside the columns. Allowing 9 feet for the uprights and free space between shell and uprights, the crane on the shortest girder can entirely overreach a vessel of about 370 feet in length and 54 feet in width, or, say, of 6,300 tons deadweight. Even a wider vessel could be built by placing the uprights under the steel structure, but this would interfere with the transport of material below this structure, which is not advisable, as the arrangement has been designed in such a manner that the material can be lifted both from top and bottom ends of the girders, also from alongside the berth and between the structure. For this purpose ordinary railways are laid on the ground space below the structure and the columns are arched so as to allow trucks and locomotive cranes to pass underneath. These arched columns are placed on reinforced concrete foundations. Of course these foundations had to be calculated to suit the important moments which may occur. With reference to these I may mention that under the most unfavorable conditions the pressures on the feet of both parts of the arched column were found to be 157 and 7 tons respectively, corresponding to a maximum moment of 156 m. tons (500 foot-tons). The nature of the soil on which the columns are placed allowed us to design the foundation in such a manner that we could dispense with any piling (which is, as a rule, required in Holland for all foundations).

The shipbuilding material can be hoisted between the two vertical girders, and for this purpose the sloping parts inside the girders (formed by the horizontal stiffeners required for wind pressure) are protected by half-round irons to prevent the plates catching the girders.

If two cranes are running on the same girder, it is essential that the railway on the ground space should extend at least about halfway down the berths, so as to avoid the one crane interfering with the working of the other. In this case the crane on the riverside is of course to be used chiefly for the after part of the vessel, and the material for this part must be deposited as far down the berth as possible. To discharge such material from the trucks small hand cranes have been fitted on the columns of the steel structure, the hoisting ropes of which can be worked by electric winches fitted between the berths. Up to the present these hand cranes have practically never been used, as the electric shipyard cranes have had time available for discharging the trucks also.

We found after a year's experience that one crane as described is quite sufficient to transport all the material required for the building of a 6,000-ton steamer, about 360 feet long, and that such a steamer can be launched practically complete for delivery, including masts, winches, etc., within four months after laying the keel; this compares favorably with any foreign record. To build two such steamers simultaneously on two adjoining berths, one steel structure with two cranes would be quite sufficient. If a yard had to be laid out for building steamers of this size only, it would consequently be advisable to adopt the following arrangement, viz., one berth, one steel structure with two cranes; for two berths, one steel structure with one crane, and so on. For two such berths the approximate cost will be as follows:

Two cranes, £1,000 each.....	£3,000
Steel structure (91 m. long).....	2,250
Concrete foundations for same.....	500
Total.....	£5,750

viz., £2,875 per berth. This initial cost is, I think, fairly low in comparison with other systems of shipyard cranes of similar efficiency.

The general arrangement adopted in our yard is somewhat different from the arrangement as suggested above. This is due to the fact that our shipyard berths are made for various sizes of vessels. The left-hand berth is intended for steamers up to about 275 feet length, the next one for steamers of about 360 feet length. As the building of small steamers is not in our line, unless they are of the fast passenger steamer type (for which quick handling of large quantities of material is of less importance), and as consequently this small berth is often used for the deposit of material instead of for the building of vessels, it was considered sufficient to fit one steel structure with one crane only between No. 1 and No. 2 berth. The next berth, No. 3, designed for vessels up to about 375 feet length, is fully covered by the second steel structure, also, with one crane. Berths 4 and 5 are

laid down for vessels of about 550 feet length. To build vessels of this size within a short time two cranes will be required, and when using the same steel structure for two adjoining berth four cranes would be necessary. While there is practically no chance of obstruction with two cranes on the same structure when the structure is about 480 feet long, it is doubtful whether the efficiency of the cranes would not be seriously compromised if four cranes were running simultaneously on such a girder.

Apart from this, when using a single structure for two berths, the cranes must overreach the full breadth of the vessels. Taking into consideration the possible width of 70 feet of steamers which are 550 feet long, the arms of such cranes would have to be much longer than those of the crane as described above. The weight of such cranes and of the steel structure would have to be increased considerably, and the cranes would be more difficult to handle.

We have had a fair opportunity of ascertaining the direct saving in wages due to the shipyard cranes, by building two sister vessels of about 6,000 tons on the same berth and under exactly the same circumstances, with this difference only, that the first ship was built previous to fitting the cranes and the second ship immediately after. The direct saving obtained by reducing the piecework rates of the ironworkers and laborers, i. e., exclusive of riveters, joiners, carpenters, smiths and painters, amounted to 6 per cent. At first sight this saving may not look very important, but, of course, apart from this direct saving there are indirect savings which are rather difficult to estimate. The cost of upkeep of wires, blocks, tackles, etc., is practically reduced to nothing. Although the piecework rates for riveting are not changed, the cost of riveting is reduced on account of the fact that the cranes allow parts of bulkheads, girders, etc., to be riveted up hydraulically on the ground before being lifted in place, instead of being riveted up by hand or pneumatically after erection in place. Another important factor is that the engineers can now put in place all their auxiliaries and shafting previous to the vessel being launched, thus obviating great delay and inconvenience in completing the vessels at the finishing berth.

Finally, there is the important saving in time of building. For the 6,000-ton vessels referred to above, built under similar circumstances, the time for the second ship was reduced from five to four months, which means an increase of output of 25 per cent and a considerable reduction of the amount of the general expenses to be charged up to each vessel, apart from the fact that the time of delivery which may be quoted often affects the contract price which may be obtained.

As an actual fact, it may be mentioned that within eighteen ordinary working days after the first keelplate was laid down, all the remaining keelplates, the bottom plating in way of double-bottom, the entire double-bottom, including center girder, intercostal floors, margin plates, tank top plating, all the frames from collision bulkhead to after peak bulkhead, two complete side stringers, and all bulkhead wing plates, also 60 shell plates, and various strong beams, all for a 6,200-ton deadweight cargo steamer, have been erected in place by the use of two cranes as described above.

As a practical result of the increased output due to the shipyard cranes, the pneumatic and hydraulic riveting plant had to be enlarged, additional shipyard machines and frame bending furnaces had to be added, and, finally, the engineering department, which had previously been always ahead of the shipbuilding department with reference to delivery, required a good many new machines to keep pace with the shipbuilding after the installation of the cranes. These extra requirements of practically all the branches of the works afford the best evidence of the efficiency of the shipyard cranes. This, in itself, is very satisfactory, but it clearly proves that when making an important improvement in a certain branch of his works a manager cannot reap the full benefits unless he can also afford the additional expense of the consequential improvements required in all the other branches.

#### Human Measurements and "Resistance Formulas"

Now that the siren voice of the recruiting officer is here abroad in the land, there is an increased interest everywhere in physical measurements and the means of improving them when they are below par. But there is another factor besides height, weight, and girth of trunk or limbs, which is highly important in determining the military value of a soldier in the field, namely, endurance, or staying power. Numerous researches have been made by military surgeons and hygienists to determine the degree of this in individuals.

The various corporeal measurements commonly made,

such as height, weight, circumference of normal and of expanded chest, respiratory amplitude, dynamometric force, girth of arms, legs, hips, etc., taken alone represent merely separate elements of strength and development. Among the various formulae for combining these to obtain a mathematical index of comparative robustness that most employed and giving the best results is said to be that of Pignet:  $T - (P + C)$ , in which  $T$  = height in centimeters,  $P$  = weight in kilograms, and  $C$  = average circumference of chest in centimeters. For a man 1.72 meters tall, weighing 68 kg., and having an average chest measure of 90 cm. this would give  $1.72 - (68 + 90) = 14$ . (5 ft. 7 in. tall, 149.6 lbs. wt., 35.1 inches average chest measure). According to Pignet the smaller this index the greater the physical strength, and the larger the index the poorer the constitution.

This index is used in Switzerland for rating recruits with reference to what may be called in brief, stamina, by means of the following table:

Index value	Result
Low = 10	Very good
11 to 20	Good
21 to 25	Average
26 to 30	Weak
31 to 35	Very weak
High = 35	Inadequate

Pignet index has recently been controlled by personal measurements of more than a thousand youths made by Dr. Fr. M. Messerli, in an endeavor to perfect a system already relatively exact. A recent number of the *Archives d. Sc. phys. et nat.* (Jan. 15, 1917) states that he has succeeded in rendering it more precise by introducing a new element: the average ( $B$ ) of the circumference of the two arms (measured in the middle of the arm while extended), from which he subtracts the original formula of Pignet. The formula thus reads  $B - [T - (P + C)]$ . Taking the individual cited above, if he has an average brachial circumference of 25 centimeters, then his numerical index would equal  $25 - [172 - (68 + 90)] = 11$ . The numerous measurements made by Dr. Messerli cause him to conclude that every positive result may be regarded as good and every negative result as inadequate, the figure 0 being the limit of the index of the weak individuals (negative) and of that of the strong individuals (positive); the more the result is positive, the more the individual is resistant; the more negative the result, the weaker the individual.

It is only by making use in the calculation of the greatest possible number of data and measurements of an individual that we can approach most nearly the index of his individual resistance.

#### Recent Data Concerning Palm Oil

PALM oil is largely employed in the manufacture of soap and candles, and also in the tin plate industry, the heated iron plates being covered with the palm oil to prevent oxidizing before they are dipped in the melted tin. Palm oil can now be refined so as to produce a pure and tasteless oil which is used in the manufacture of margarine. There is an abundant supply of palm fruits available in West Africa, large areas of forests being still untouched. Palm oil is obtained from the pericarp or outer pulpy layer of the fruit of the West African oil palm (*Elaeis guineensis*), while the kernels are secured by shelling the palm nuts which are left when the pericarp is removed from the fruit. The kernels yield from forty-six to fifty three per cent of white or pale yellow solid fat, possessing a pleasant nutty taste and resembling coconut oil in appearance and properties. This oil obtained from the palm kernels is used in the manufacture of soap and candles and in the preparation of edible fats such as margarine, cooking fats, vegetable butters and chocolate fats. The cake or meal which is left after expression or extraction of the oil from palm kernels is of value as a cattle food. Most of the palm oil comes from Nigeria, but the kernel oil was largely produced in Germany. Up to the time of the war, the West African kernels were mainly shipped to Germany, where the oil was pressed and shipped to Great Britain, either unrefined or manufactured into butter substitute. The crushing of palm kernels has now been taken up by British oil seed crushers, and the present valuable trade is centered in that country. Imports of palm kernels in 1915 were 11,662 tons valued at £3,909,269, of which by far the greater part is produced in Nigeria, followed by Sierra Leone and French West Africa. Native cultivation of oil palms in the Gold Coast is being neglected in favor of cocoa, but European enterprise is introducing central factories for the scientific and economical manipulation of the produce, and there is good reason to suppose that this will soon prove beneficial to the industry and the natives alike.—From the London Chamber of Commerce Journal.

## Insects That Deceive

### How Nature Protects Its Weaker Members

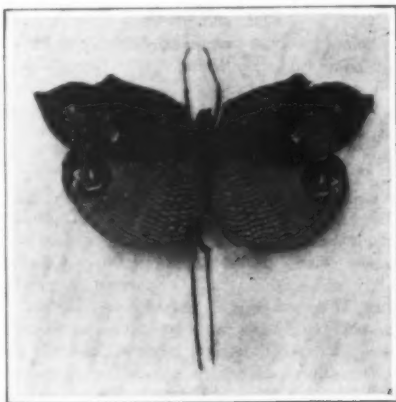
By Dr. J. Bergner

WONDERFUL beings are shown in our illustrations, queer in their general appearance and still by no means ugly in their structure; forms which perhaps satisfy to a slight extent our esthetic conceptions, but particularly arouse the interest of an attentive friend of nature. In their natural surroundings, these locusts—it is of them that we are speaking—are not readily noticed, and in their shape and colors they agree with their surroundings so closely that, when in a state of rest, they can be scarcely noticed at all. Found chiefly in hot countries, they are not only giants, having a length of over 30 centimeters, but have puzzling shapes, which raise in the mind of everyone who is interested in the world around him the thought: "how could such things appear and what is the purpose of this animal masquerade?" The great teacher, nature, gives the best information as soon as we take the trouble to investigate closer the habits of life of these apparently preposterous beings. It was not a mad whim of the creating forces, and not an unexplainable *lusus naturæ* (as one formerly called these beings), but "mimicry" in the pure sense of the word. Deceit is the purpose of their peculiar formation so as to

give these beings, but little suited for fighting, a certain protection from the keen vision of their enemies, by enabling them to imitate inanimate things (in this case branches and leaves). This is a phenomenon known as mimicry, which plays an important part in the animal kingdom. A bright butterfly when it suns itself in its flight spreads up and down its many-colored wings. Our approach frightens it, and suddenly it disappears from sight. The invisible under side of its wing which, like an impressionist picture, imitates wood bark with its spots and lines, enables it when it sits against the body of a tree with its wings drawn together, to appear for all practical purposes like a piece of bark. There are also many smooth caterpillars extensively devoured by birds, which are able to imitate other objects. Sometimes when at rest they are all rolled up like a snail shell, or as in the case of the spanworm, sticking out rigid and straight, like a little bough; such forms as are here shown can be seldom observed because they occur but very infrequently and only in Southern Europe.

The "praying cricket," which is about 7 centimeters long, is one of the most remarkable insects. It is frequent in Italy and Southern France, is found in Austria in the vine region, as well as in Germany in many places, with Frankfurt-on-the-Main as its northernmost limit. It was most likely brought there by the Romans who were the first to plant vines here. As wonderful as its name is the animal itself. Everyone who has seen this insect is surprised, for it has a head like a horse, with large eyes; and this head can move in every direction much more easily than a man can move his head. Its name, "Praying Cricket," which has the same significance in all languages, is due to its front paws being raised in an attitude of prayer, and on account of the dignified quiet in which it is usually standing. Its scientific name, *Mantis Religiosa*, coincides with the native popular denominations, since the word Mantis in Greek and Roman meant a prophet, such as would offer his prayer to the Lord in a similar attitude. The ancients, who had much respect for signs, ascribed to it the gift of prophecy; the extending of its right or left arm would indicate the right road to the inquirer! According to others the appearance of the praying cricket foretold hunger. Here apparently the praying cricket was confused with the migratory Locust, swarms of which, big enough to darken the sunlight, devoured everything on the ground and thus produced starvation.

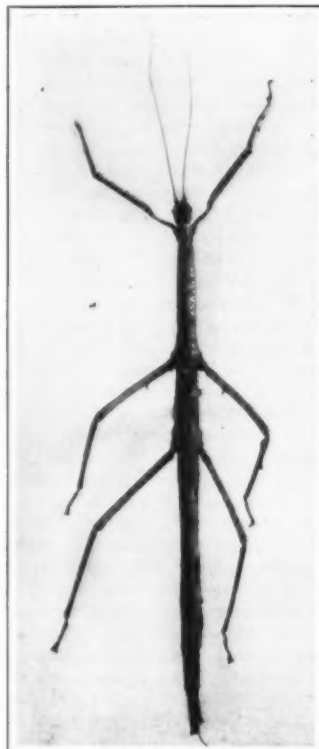
As a matter of fact, however, the praying cricket is by no means the mild, loving creature which is indicated



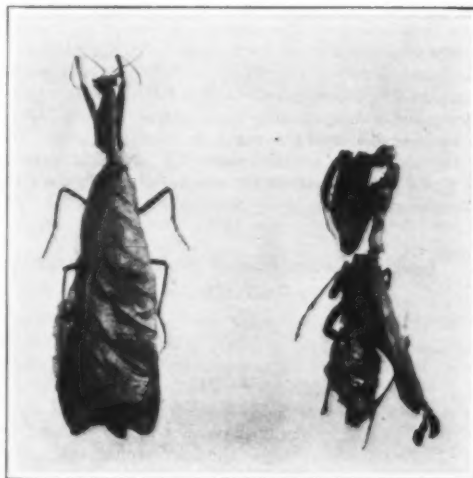
South American Stone Cricket, with wings spread  
(*Porphyroma Santina*)



Walking Stick of New Guinea  
(*Cyphorania Marulata*)



The Walking Stick  
(*Phibalosoma lepelletieri*)



South American Praying Mantis  
(*Aranthops mortuifoliar*)

by its name and the attitude which makes us think of prayer. In this case it indicates not prayer; behind the penitent appearance are concealed falsehood and cunning. Unlike all other locusts the Mantis lives on living beings. Its arms raised as if in prayer, are really veritable weapons which grip every insect which comes within its reach. These predatory limbs, provided with sharp barbs, act like the blade and haft of a knife, and in their refined shape represent a weapon which, especially in the larger species of insects, can cause pain even to a human being. The powerfully-developed first joint shows the strength of the muscles of this gripping apparatus. Green, like the color of the leaves between which it keeps itself, the praying cricket sits for hours on watch among the grass and foliage, with its grips raised up and forward and its remarkably long neck just like a blade of grass, which still more helps its resemblance to its surroundings. It is a typical example of so-called protective coloring, because if we let our eyes wander away from the little insect for only a short time it is quite difficult to find it again among the intertwining blades of grass. If, however, an artless fly, a little beetle, or any other animal of the size that the little robber can handle comes near, she follows it with her eyes, cautiously steals up like a cat to spring at it at the right moment. The unfortunate victim is gripped between the jaws of one of the arm grips, the other arm catches it and forces it to the teeth after which it is devoured with the greatest avidity. We see now why the praying cricket when at rest always holds this pair of arms high up and does not use them in her slow and dignified walk. These arms have lost their original purpose, have been turned over to the service of food supply and have, therefore, undergone a considerable transformation. Another variation, however, followed this, and that is what explains also the unusual development of the neck and the elongated bar-shaped breast which enables the head to get to the place where the struggling victim is being held. This transformation, however, led to such an alteration of the entire forward part of the body that it would be only a hindrance in flying: hence, the little female which is fairly plump anyway is sentenced to a life on the ground. The green wing-cases help the little robber, who is lurking in wait for its victim with as much cunning as persistence, to conceal itself from the sight of its victim as well as from attack of its enemies, from which

once seen it would have been unable to escape. The gripping apparatus of the praying cricket is, therefore, a typical illustration of the fact that in nature a local adjustment leads to a series of changes, one after another, and finally produces alterations in the whole organism.

The Mantis is, however, not only one of the most adventurous and interesting insects to be found in Europe but is also a being of tremendous voracity and possessed of a wild lust of killing. Even when it has plenty of food it will not let another animal escape, not even its own male. The larger praying crickets of the tropics venture even to attack birds, although the latter could kill them with a couple strokes of the beak. They manage to kill insects far larger than they are themselves. They do it by frightening them into offering no resistance, and this they do by assuming a threatening, fighting attitude. With the wings raised high and the rasping noise produced by rubbing them against her back, the Mantis follows each movement of its victim with her fascinating eye and the victim, made rigid by fright, often sits still and waits instead of saving itself by flight. Then, a lightning spring, the victim is gripped like a vise, and a bite in the neck severs its brain nerve, thus making all other further resistance impossible. Then

follows a cannibal feast. The above described posture somewhat similar to the bristling feathers of a fighting cock, led to the adoption of the name Wine Cock by the Moravian Wine growers. Its main purpose, however, is to produce a terrifying expression by a sudden expansion of the wings, because the plumpness of the female insect prevents flight anyway. The more powerfully built and not so perfectly equipped male, on the other hand, needs his wings, if only to find the female more easily. He merrily flutters from bush to bush, but, once lost to the eye, he is very difficult to find again, so well is he concealed by his green, leaf-like coloring.

This similarity is more pronounced in many tropical species which in coloring, shape and design imitate not only green, but also wilted and fallen-off leaves, even mildew-mold and other shades of dead leaves being reproduced with the most wonderful truth to nature. This resemblance, however, is limited to the upper wing case; the lower surface of the wing often has a brilliant, mostly red, color with spots and brilliant lines. When at rest, however, the insect is covered by its little, visible front wings, which are drawn together so that nothing interferes with its similarity to the leaves. There is a great variety in the appearance of the legs, which are either long and thin, or widened out at various places; if they do not look like leaf appendages, such as moss.

This transformation goes the farthest in the case of *Phyllium siccifolium*, the Wandering Leaf, as it is known in its Indian home country. Not only does the exterior of the wings of this remarkable little animal look like a leaf, with all its veins and ribs, but its appendages are also wonderfully like leaf parts. Even the eggs which it lays look like certain plant seed. Much prized as a



Wandering Leaf  
(*Phyllium siccifolium*)

have no wings while the males, found much rarely, have them quite often, in order that they may, with the object of obtaining their species, flutter from tree to tree. Among them are giants, in size not exceeded by any other insect. Similar gigantic types lived also in the far-away days when the climate was warmer than it is now, and coal was being formed from primeval tropical forests. Now there are found only two small types in the south of Central Europe, in France and Italy, which, with the forelegs stretched out, do not exceed 10 centimeters. They are easy to breed, and many will be glad to hear that their eggs can be bought at a moderate price from dealers.

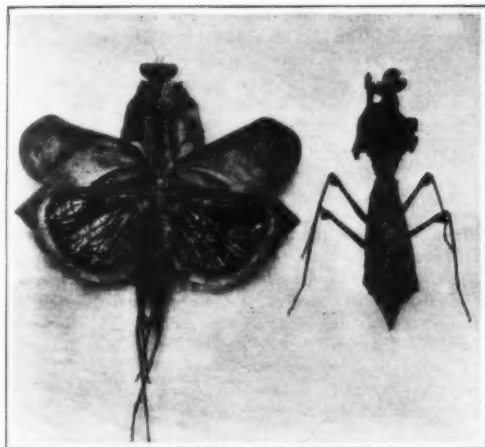
It remains to determine how such far-reaching adaptations could have occurred. Small changes, such as occur in all types of animals, may have given the first

impetus to it. If they were of service to the animal, they persisted, were transmitted by heredity, and were intensified with each case of selection. It has been pointed out that among the progeniture of normal types there occur suddenly some which are materially different from their parents, and such types perpetuate themselves with all their peculiarities. Such "sudden variations" may repeat several times, so that, even without a slow-working process of "selection," quite peculiar types may develop in a few stages. The influence of surroundings, with their light, air and temperature relations, may, together with biological influences, lead to the rise of such variations. In any case, we have to deal here not with pure accidents, but with phenomena subject to certain laws which have finally so modified animals either requiring protection, or lying in wait for prey, that they have become real types of animal mimicry.

#### Dasheen Finds Favor

Root Crop Comparable to the Potato Newly Introduced in South

THE dasheen, a root crop introduced into this country, from Trinidad, within recent years, by the United States Department of Agriculture, is now grown by a considerable number of farmers and truckers in the South, and promises to become a valuable member of the group of domestic vegetables, such as the potato, which furnish starchy foods. The new vegetable is closely related to the taro, which is an important factor in the food supply in portions of the Tropics. The dasheen is itself primarily a tropical plant. It can be grown successfully, however, not only in the warmer portions of Florida but in other sections of the South as far north as South



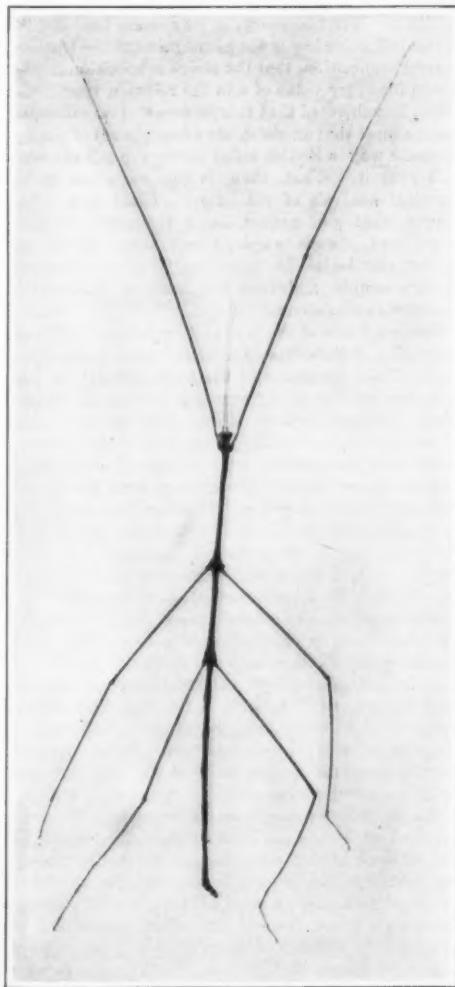
Indian Praying Mantis  
(*Deroplatys desierata*)

natural curiosity, the animal which looks like a lemon leaf is collected by natives and sold.

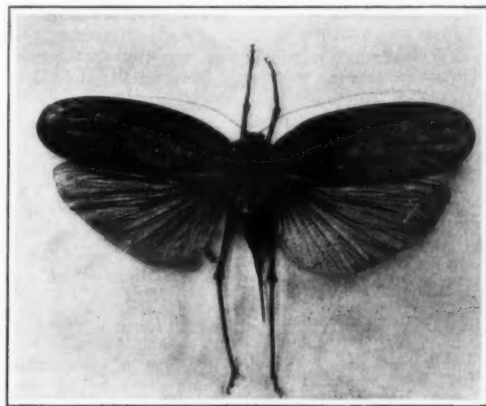
While the locust just described with its wide body looks like a leaf, there are also types which with their wings raised high sit on branches like pedunculate leaves. Most of them are grass locusts, found most frequently in well-wooded countries, such as Brazil. The largest of them is the *Phyllophora gigantea*, found in New Guinea, with a spread of wings of more than 0.25 meter.

The appearance of animals of various kinds looking like leaves of a tree has since the oldest times given rise to various fables. Thus, Plinius (79 B. C.) and other authors of antiquity speak of leaves which have become alive; and as late as 1658, Piso, in the history of the two Indies, said that these animals turn into nice, green plants by setting their legs hard into the ground, where under the influence of the moisture of the earth they begin to sprout roots. The natives on the other hand say even now that these animals start by growing as leaves of the tree and then fall off and become flying insects.

If the forms hitherto described could be considered as wandering leaves, the following would have to be described as living boughs. They are mostly weird shapes, which, on account of their long skeleton-shaped bodies have received the name of Specter Locusts. They look like green or brown branches, since, when at rest, their long, thin arms stick out from the body without any symmetry. Relying on this protective similarity and appearing to be dead whenever there is danger they sit supinely on trees and bushes, the leaves of which give them food. As this locust likes to rest with its forelegs stretched out forward, or uses them as organs of touch in climbing, their inner side is hollowed out, so that the head of the insect fits exactly in the cavity produced, and the thin forelegs can be rigidly stretched out forward, close to one another. The females in most cases



Spectre Locust of India



Great Stone Cricket  
(*Phyllophora gigantea*)

Carolina. The edible portion of the plant includes a large central corm and a number of tubers, of much smaller size, attached to and around the corm.

The value of the dasheen, it is believed, will be as a crop supplemental to, rather than a substitute for the, potato. The fact that the dasheen matures in the fall when potatoes must be obtained from northern producing sections, should make the new plant especially valuable in the economics of the southern farmer.

In food value the dasheen is comparable to the potato, though it contains a smaller proportion of water and a greater proportion of protein, starch, and sugar than the latter. The new vegetable may be prepared for the table as potatoes usually are, or may be made into flour and used in baking. The tender shoots forced from the large corms may be prepared like asparagus, and make a pleasing dish in that form.

The dasheen is grown from the whole tubers weighing a few ounces. They require a frostless season of at least seven months, with plenty of moisture. A moist but well-drained, rich, sandy loam has been found to be a satisfactory soil for dasheen culture. A large proportion of either clay or muck in the soil produces strong-flavored, tough corms, which are often unfit for table use. Large crops are produced under such conditions, however, and make excellent stock feed.

The crop is planted in February in southern Florida and as late as the early part of April in South Carolina. The plants are spaced about three and one-half by three and one-half feet. Dasheens may be dug for home use by the middle of September and the main crop can be harvested at any time after the last of October. The clumps of tubers are left on the surface of the ground for several days to dry. The tops and small roots are then broken off and the dasheens placed in storage.

The dasheen is a good shipper and is handled by the carriers at the same freight rates as potatoes. The vegetable has already found its way into a number of northern markets.—*Weekly News Letter*, Dept. of Agriculture.

# The Organization of Thought—II\*

## The Basis of Organized Action

By Prof. A. N. Whitehead, Sc.D., F. R. S.

CONCLUDED FROM SCIENTIFIC AMERICAN SUPPLEMENT No. 2161, PAGE 339, JUNE 2, 1917

THE fourth logical section, the analytic stage, is concerned with the investigation of the properties of special logical constructions, that is, of classes and correlations of special sorts. The whole of mathematics is included here. So the section is a large one. In fact, it is mathematics, neither more nor less. But it includes an analysis of mathematical ideas not hitherto included in the scope of that science, nor, indeed, contemplated at all. The essence of this stage is construction. It is by means of suitable constructions that the great framework of applied mathematics, comprising the theories of number, quantity, time, and space, is elaborated.

It is impossible even in brief outline to explain how mathematics is developed from the concepts of class and correlation, including many cornered correlations, which are established in the third section. I can only allude to the headings of the process which is fully developed in the work, "Mathematica Principia," by Mr. Russell and myself. There are in this process of development seven special sorts of correlations which are of peculiar interest. The first sort comprises one-to-many, many-to-one, and one-to-one correlations. The second sort comprises serial relations, that is, correlations by which the members of some field are arranged in a serial order, so that, in the sense defined by the relation, any member of the field is either before or after any other member. The third class comprises inductive relations, that is, correlations on which the theory of mathematical induction depends. The fourth class comprises selective relations, which are required for the general theory of arithmetic operations, and elsewhere. It is in connection with such relations that the famous multiplicative axiom arises for consideration. The fifth class comprises vector relations, from which the theory of quantity arises. The sixth class comprises ratio relations, which interconnect number and quantity. The seventh class comprises three cornered and four cornered relations which occur in geometry.

A bare enumeration of technical names, such as the above, is not very illuminating, though it may help to a comprehension of the demarcations of the subject. Please remember that the names are technical names, meant, no doubt, to be suggestive, but used in strictly defined senses. We have suffered much from critics who consider it sufficient to criticize our procedure on the slender basis of a knowledge of the dictionary meanings of such terms. For example, a one-to-one correlation depends on the notion of a class with only one member, and this notion is defined without appeal to the concept of the number one. The notion of diversity is all that is wanted. Thus the class  $a$  has only one member, if (1) the class of values of  $x$  which satisfies the propositional function,

$x$  is not a member of  $a$ ,

is not the whole type of relevant values of  $x$ , and (2) the propositional function,

$x$  and  $y$  are members of  $a$ , and  $x$  is diverse from  $y$ , is false, whatever be the values of  $x$  and  $y$  in the relevant type.

Analogous procedures are obviously possible for higher finite cardinal members. Thus, step by step, the whole cycle of current mathematical ideas is capable of logical definition. The process is detailed and laborious, and, like all science, knows nothing of a royal road of airy phrases. The essence of the process is, first to construct the notion in terms of the forms of propositions, that is, in terms of the relevant propositional functions, and secondly to prove the fundamental truths which hold about the notion by reference to the results obtained in the algebraic section of logic.

It will be seen that in this process the whole apparatus of special indefinable mathematical concepts, and special *a priori* mathematical premises, respecting number, quantity, and space, has vanished. Mathematics is merely an apparatus for analyzing the deductions which can be drawn from any particular premises, supplied by common sense, or by more refined scientific observation, so far as these deductions depend on the forms of the propositions. Propositions of certain forms are continually occurring in thought. Our existing mathematics is the analysis of deductions, which concern those forms and in some way are important, either from practical utility or theoretical interest. Here I am speaking of the

science as it in fact exists. A theoretical definition of mathematics must include in its scope any deductions depending on the mere forms of propositions. But, of course, no one would wish to develop that part of mathematics which in no sense is of importance.

This hasty summary of logical ideas suggests some reflections. The question arises, How many forms of propositions are there? The answer is, an unending number. The reason for the supposed sterility of logical science can thus be discerned. Aristotle founded the science by conceiving the idea of the form of a proposition, and by conceiving deduction as taking place in virtue of the forms. But he confined propositions to four forms, now named A, I, E, O. So long as logicians were obsessed by this unfortunate restriction, real progress was impossible. Again, in their theory of form, both Aristotle and subsequent logicians came very near to the theory of the logical variable. But to come very near to a true theory, and to grasp its precise application, are two very different things, as the history of science teaches us. Everything of importance has been said before by somebody who did not discover it.

Again, one reason why logical deductions are not obvious is that logical form is not a subject which ordinarily enters into thought. Common sense deduction probably moves by blind instinct from concrete proposition to concrete proposition, guided by some habitual association of ideas. Thus common sense fails in the presence of a wealth of material.

A more important question is the relation of induction, based on observation, to deductive logic. There is a tradition of opposition between adherents of induction and of deduction. In my view, it would be just as sensible for the two ends of a worm to quarrel. Both observation and deduction are necessary for any knowledge worth having. We cannot get at an inductive law without having recourse to a propositional function. For example, take the statement of observed fact:

This body is mercury, and its specific heat is 3.033.

The propositional function is formed,

Either  $x$  is not mercury, or its specific heat is 0.033.

The inductive law is the assumption of the truth of the general proposition, that the above propositional function is true for every value of  $x$  in the relevant type.

But it is objected that this process and its consequences are so simple that an elaborate science is out of place. In the same way, a British sailor knows the salt sea when he sails over it. What, then, is the use of an elaborate chemical analysis of sea-water? There is the general answer, that you cannot know too much of methods which you always employ; and there is the special answer, that logical forms and logical implications are not so very simple, and that the whole of mathematics is evidence to this effect.

One great use of the study of logical method is not in the region of elaborate deduction, but to guide us in the study of the formation of the main concepts of science. Consider geometry, for example. What are the points which compose space? Euclid tells us that they are without parts and without magnitude. But how is the notion of a point derived from the sense-perceptions from which science starts? Certainly points are not direct deliverances of the senses. Here and there we may see or unpleasantly feel something suggestive of a point. But this is a rare phenomenon, and certainly does not warrant the conception of space as composed of points. Our knowledge of space properties is not based on any observations of relations between points. It arises from experience of relations between bodies. Now a fundamental space relation between bodies is that one body may be part of another. We are tempted to define the "whole and part" relation by saying that the points occupied by the part are some of the points occupied by the whole. But "whole and part" being more fundamental than the notion of "point," this definition is really circular and vicious.

We accordingly ask whether any other definition of "apatial whole and part" can be given. I think that it can be done in this way, though, if I be mistaken, it is unessential to my general argument. We have come to the conclusion that an extended body is nothing else than the class of perceptions of it by all its percipients, actual or ideal. Of course, it is not any class of perceptions, but a certain definite sort of class which I have not defined here, except by the vicious method of saying that they are perceptions of a body. Now, the perceptions of a

part of a body are among the perceptions which compose the whole body. Thus two bodies  $a$  and  $b$  are both classes of perceptions; and  $b$  is part of  $a$  when the class which is  $b$  is contained in the class which is  $a$ . It immediately follows from the logical form of this definition that if  $b$  is part of  $a$ , and  $c$  is part of  $b$ , then  $c$  is part of  $a$ . Thus the relation "whole to part" is transitive. Again, it will be convenient to allow that a body is part of itself. This is a mere question of how you draw the definition. With this understanding, the relation is reflexive. Finally, if  $a$  is part of  $b$ , and  $b$  is part of  $a$ , then  $a$  and  $b$  must be identical. These properties of "whole and part" are not fresh assumptions, they follow from the logical form of our definition.

One assumption has to be made if we assume the ideal infinite divisibility of space. Namely, we assume that every class of perceptions which is an extended body contains other classes of perceptions which are extended bodies diverse from itself. This assumption makes rather a large draft on the theory of ideal perceptions. Geometry vanishes unless in some form you make it. The assumption is not peculiar to my exposition.

It is then possible to define what we mean by a point. A point is the class of extended objects which, in ordinary language, contain that point. The definition, without presupposing the idea of a point, is rather elaborate, and I have not now time for its statement.

The advantage of introducing points into geometry is the simplicity of the logical expression of their mutual relations. For science, simplicity of definition is of slight importance, but simplicity of mutual relations is essential. Another example of this law is the way physicists and chemists have dissolved the simple idea of an extended body, say of a chair, which a child understands, into a bewildering notion of a complex dance of molecules and atoms and electrons and waves of light. They have thereby gained notions with simpler logical relations.

Space as thus conceived is the exact formulation of the properties of the apparent space of the common-sense world of experience. It is not necessarily the best mode of conceiving the space of the physicist. The one essential requisite is that the correspondence between the common sense world in its space and the physicists' world in its space should be definite and reciprocal.

I will now break off the exposition of the function of logic in connection with the science of natural phenomena. I have endeavored to exhibit it as the organizing principle, analyzing the derivation of the concepts from the immediate phenomena, examining the structure of the general propositions which are the assumed laws of nature, establishing their relations to each other in respect to reciprocal implications, deducing the phenomena we may expect under given circumstances.

Logic, properly used, does not shackle thought. It gives freedom and, above all, boldness. Illogical thought hesitates to draw conclusions, because it never knows either what it means, or what it assumes, or how far it trusts its own assumptions, or what will be the effect of any modification of assumptions. Also the mind untrained in that part of constructive logic which is relevant to the subject in hand will be ignorant of the sort of conclusions which follow from various sorts of assumptions, and will be correspondingly dull in divining the inductive laws. The fundamental training in this relevant logic is, undoubtedly, to ponder with an active mind over the known facts of the case, directly observed. But where elaborate deductions are possible, this mental activity requires for its full exercise the direct study of the abstract logical relations. This is applied mathematics.

Neither logic without observation, nor observation without logic, can move one step in the formation of science. We may conceive humanity as engaged in an internecine conflict between youth and age. Youth is not defined by years, but by the creative impulse to make something. The aged are those who, before all things, desire not to make a mistake. Logic is the olive branch from the old to the young, the wand which in the hands of youth has the magic property of creating science.

### Immense Consumption of Incandescent Lamps

It is stated that in 1916 the Edison Lamp works sold 73,500,000 incandescent lamps. Approximately one-third was sold direct to central stations, one-third direct to street railways and other purchasers, and the remaining one-third through jobbers and dealers as agents.

\*An address to the Mathematical and Physical Science Section of the British Association, at Newcastle. Reported in *The Chemical News*.

### Reform of Food Distribution

By John J. Dillon, Commissioner, Department of Foods and Markets, State of New York

THE design, shaped through my experience for the encouragement and increase of food supplies and economic distribution, applies to every city or consuming and distributing center in this country.

Let us take its application to Greater New York for pointed illustration. New York City is the greatest food market in the world. It consumes \$800,000,000 worth of food annually. Probably a fourth more, at least, is received and re-shipped to other consumers. Thus New York has now to deal with the handling of a billion dollars' worth of food products from year to year.

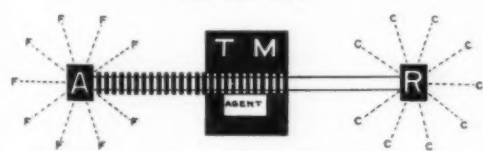
It was the conclusion of the New York State Investigating Committee in 1912 that "the producer seems to be receiving about forty per cent of the retail price. That is absurd; he should receive from sixty to seventy per cent." What now blocks reasonable or adequate returns to the producer? Crude, bungling, speculative, wasteful and antiquated mediums of distribution. Surely the jumble does not merit the name of a mechanism of supply. Does this concern the producer alone? On the contrary it is demonstrable and has been proved over and over again in practice, that the consumer profits proportionately from every reform of the method of distribution. This is pithily shown in the improved marketing of citrus fruit in New York and the hobbling extension of like method to apples and other products.

In the urgency of a radical or thorough-going reform I should not neglect any immediately feasible or make-shift improvements for the marketing of any food product. But the extortion and waste of an amount not less than one hundred and fifty millions yearly in New York City alone, is a drain that surely demands bung-hole stoppage with the least possible delay.

What is the operation and what are the glaring defects of the present marketing methods? Now the drummer for a commission dealer goes to the farmer and solicits shipments. Competition piles up this needless cost. There is no assembling place in a country district in the State for shipments. The products are not graded properly as a rule or packed properly. Usually high freight rates for small lots are paid. There is no adequate terminal market in the City. The goods drift along to the thousands of retailers through a maze of dealers, wholesalers and jobbers. The first sale is often made by the commission dealer to himself. Often they go through six or seven hands. Each adds a burden of toll to the food and deteriorates its quality by time and handling. There is no check on the retailer, and the consumer must pay the burden of all the charges for needless handling, resales and carting. Is it to be wondered at as an outcome that less than five per cent of the food products entering New York City are shipped from the farms of the State and that we face the exhibit of two million acres of idle land?

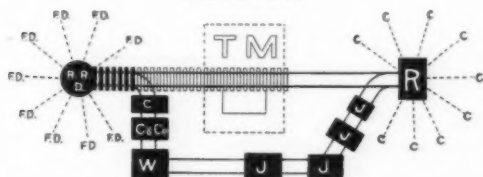
Is it conceivable that the people of the State, the great constituent body of producers and consumers, will put up with the scheme of taxation when their eyes are opened? For graphic impress I would contrast it with the change which I urge in the accompanying diagram:

OLD AND NEW SYSTEMS  
THE NEW WAY



F., farmer; A., assembling; T. M., terminal market; R., retailer; C., consumer.

THE OLD WAY



F., farmer; D., drummer; R.R. D., railroad station; T. M., terminal market; C., commission dealer; C. & Co., commission dealer & Co.; W., wholesaler; J., jobbers; R., retailer; C., consumer.

Producers organized in a cooperative association are to own or rent the assembling house at A on the railroad. A farmer brings his produce to this place and goes home with a receipt for the total weight. The Association Manager grades the loads delivered and credits the farmer with the weight of the different grades. Then he packs the assorted produce for shipment in car load lots to the city market, reserving sufficient for the supply of local dealers and buyers for home consumption, and protecting

the reasonable profit of the retailer in his agency sales to consumers. From hundreds of assembling houses of this description car loads of produce thus properly prepared will run direct to the New York City Terminal Market over all railroads entering the City. Automatic machinery will carry produce direct from ships to the same terminal. This great receiving establishment will be equipped with cold storage and common storage facilities and manufacturing plants to use up all tender stock and prevent waste. All farm produce will be weighed, inspected and sold in this market. Direct sale to the retailer will be encouraged under license to be issued by the Commissioner of Foods and Markets. Official price records will be published daily and all sales will be under constant supervision to prevent impositions.

The costs of operation at this terminal market under such conditions will be only a small fraction, probably not exceeding three per cent of the volume of sales. Goods assembled in this way are easily and cheaply inspected. Correct grading will facilitate sales direct to retailers and increase the demand. Prices will be made on the basis of supply and demand. Disposal will be by auction or private sales as the case warrants.

No more direct, speedy and economic system can be devised, in my judgment, and this brief outline sketch can be fortified at every point and made adaptable to every needed requirement.

### The Photometry of Luminescent Substances\*

By Arthur Blok

THE measurement of the brightness of fluorescent and phosphorescent substances is rendered difficult by two factors—(i.) the color of the light, the spectrum of which usually consists of bands or lines situated mainly in the green or blue; and (ii.) the relatively low luminosity. Both of these factors tend to introduce the Purkinje effect. Fortunately, the chief data required are usually relative, and one can thus work throughout with a colored screen placed in front of a comparison lamp, and designed to give a color which more or less matches the light of the material tested. If one wishes to obtain absolute values of brightness, allowance must be made for the absorption of the screen; but the procedure for effecting this introduces all the physiological difficulties attendant on heterochromatic photometry at low illuminations. An approximate color match may be obtained fairly easily, for example, by the use of signal green glass in testing phosphorescent zinc sulfide, but unless the spectral composition of the two lights compared is substantially identical, errors may be introduced by the order of luminosity at which the test is made, the part of the retina upon which the image is received, and perhaps, also, by the size of the photometric surface employed.

Various photometric methods have been devised for dealing with this class of substances, and in these a color-matching screen is almost always employed. In the method described by N. E. Dorsey,<sup>1</sup> a lamp is moved back and forth behind a translucent screen forming one end of a box, and the luminous compound under test is mounted on the outer surface of the screen either in the form of paint on a card slip or in powder form in a thin-walled glass tube. Identity of color is produced by a color filter placed inside the box between the lamp and the screen. With this arrangement, the tested sample appears as a luminous island in a surrounding sea formed by the variably illuminated screen, and provided that a sharp line of demarcation can be obtained between the island and sea, there is much to recommend this plan—immediate contiguity of the two luminous areas under comparison greatly facilitates the determination of photometric balance.

In the method used at the National Physical Laboratory for comparing the luminosity of painted dials, a stencil replica of the dial under test is uniformly illuminated from behind by means of a glow lamp and a color screen. The stencilled and actual dials are mounted side by side, and by means of a variable resistance the candle-power of the lamp is brought to such a value that the luminosities of the stencilled figures and those on the actual dial are the same. By an independent calibration with a surface-brightness photometer, the brightness of the stencil for any resistance setting is known. Here, the mean effect over the whole of the surfaces viewed is judged, and as long as the dials are small there should be little difficulty in doing this. But if the dials are large, the various figures will be at different distances from the eye, and it would appear that trouble may be introduced on that account. The method, however, has the advantage that by enabling finished dials to be dealt with in their entirety it gives a final comparison of their merits, whereas if small samples of paint are measured there is always the possibility that variations in the

\*An introduction to a discussion before the Illuminating Engineering Society (England), and published in *The Illuminating Engineer*.

<sup>1</sup>Bulletin, Washington Academy of Sciences, Jan. 4, 1917.

finished article may be introduced during the painting operation, for example, by irregular mixing or uneven application of the paint.

In another scheme, developed by Prof. Clinton and Mr. Dow for measuring some very small samples in association with the speaker, the sample is viewed at a constant distance from the eye through a small opening in a white screen placed at an angle of 45 degrees to the line of sight and to the axis of the photometer bench (the line of sight being normal to the bench axis). The opening is of such a size as to be completely filled by the luminous specimen fixed behind it—i. e., the "island and sea" plan is adopted. The inverse square of the distance of the lamp from the screen at photometric balance is proportional to the luminosity of the sample.

A point to be borne in mind in speaking of the photometric values of self-luminescent substances is that the luminosity of the material in powder form is considerably higher than when the material is mixed with varnish or other substance to form a paint. Moreover, the thickness of the layer tested to some extent determines the foot-candle value. A further factor which may influence the result in the treatment of the substance in regard to exposure to light before the test. In the case of substances like Balmain's compound, this is obviously a matter of prime importance, but with materials depending on radio-active excitants for their luminosity, the effect of previous light action is, as far as the speaker is aware, not yet thoroughly known. Indeed, it is very evident that for the systematic specification of these self-luminous substances standard test conditions still remain to be worked out.

For some purposes, a single photometric measurement on any of these materials may suffice, but usually it is equally important to know the rate of luminous decay with the lapse of time. It is somewhat remarkable that although the chemical and physical sides of radio-activity and phosphorescence have been brought to a very advanced stage, very little appears to have been published on the luminous values of the substances now under discussion, and one looks almost in vain for data on the practical matter of variation of foot-candle values with time for a compound of a given nature. The present activity in night operations in war has caused a very great demand for self-luminous compounds and, no doubt, the results of tests extending over moderately long periods will be available presently. Such tests require very great care, for at best the initial luminosities under measurement are small, and after some time they sink to values that are very difficult indeed to measure, at any rate by the eye, which after all is the instrument with which the substances are used in practice. The products now used commercially have brightnesses of the order of a few hundredths of a foot-candle, and give nearly monochromatic lights. These are conditions that tax the photometrist, and the repetition of observations to five or six per cent in tests of this nature would indicate very good work.

On the whole, there seems to be a large field for the application of photometric methods in the investigation of these substances. The subject of self-luminescent materials is at the interesting stage where practical applications are emerging, and those who are conversant with the better known applications of photometry in lighting work generally might well devote attention to the investigation of the luminous phenomena exhibited by the class of bodies now being discussed.

### Burned Grain or Flour

It is observed that in case of fire, wheat and flour do not burn to any great extent, but are spoiled by water and smoke. As there are frequent cases where grain is called upon to suffer from fire during the war, a few considerations on this subject will be timely, especially as regards the subsequent use of such grain or flour as can be saved. Following the fire at the Mans grain elevators in France, M. Ernest Vidière made a series of tests to see what use could be made of wheat and flour left from the fire. Thirty sacks of wheat were milled and the flour tested, and again, samples of flour were taken direct. In both cases, exposure to the air lessened the burnt odor and the flour could be made into bread. This latter showed different results, and varied between good tasting and disagreeable, according to the case, but in general the bread was of fair quality. Wheat increases in density somewhat because it is dried by the fire, for instance, the proportion is 1 to 1.13. Five per cent of the grain was carbonized. It appears that bran will remove the odor from flour; for instance 50 parts of flour were mixed with 25 parts of fresh bran, and left in contact for four days at 20 degrees Centigrade, then put through the bolting process, and it was found that the flour was deodorized, for the bran absorbs the odor. Wheat that is simply smoked and not burned can be sorted, and a part of it used for seed.

### The Pagan Tribes of the Philippines.\*

DR. COLE first took up the peopling of the Islands and the intermingling of peoples which has resulted in the present population. The pigmy blacks or Negritos were held to be the aboriginal inhabitants of the islands. They were driven back from the coasts, and finally to a few isolated regions by the pressure of invaders, most of whom came in from the south. Many of the pigmies were enslaved or otherwise merged with newcomers and, as a result, traces of this intermixture are now to be seen in every tribe of the Philippines.

The invading peoples are believed to have come in several waves, not as a part of a great single movement. The earliest of these waves appears to have been made up of a people who were physically closely allied to the Polynesians. They were followed by successive invasions of primitive Malays—a people with closer affinities to the Mongoloid people of Southern Indo-China and the earlier inhabitants of Burma. These early inhabitants appear to have intermarried to a great extent, and later to have mixed with newcomers so that today the population is of a very complex nature. Dr. Cole showed a number of slides of members of the Bukidnon tribe of Central Mindanao. In this group three types continually appear—oftentimes in the same family. The first type has distinct negroid features showing the admixture of Negrito blood; the second closely approximates the Christianized Visayan of the Coast; while the third element is made up of people who in all but color closely resemble Caucasians.

The effect of movements of alien peoples and beliefs into Malaysia, in historic times, was also sketched. Traces of the Hindu-Buddhist movement are evident especially in the folk-lore; while the great effects of the introduction of Mohammedanism and Christianity on the bulk of the population are a part of historic record.

The greater part of the evening was devoted to a description of the most fundamental facts of the religious, social, and economic life of three pagan tribes—the Bagobo of Southern Mindanao, the Bontoc Igorot, and the Tinguian of Northern Luzon.

The Bagobo live on the lower slopes of Mt. Apo, the highest mountain of the Philippines. Near the summit of this mountain is a deep fissure from which clouds of sulfur fumes and steam are continually rising, while frequent earthquakes give evidence of latent energy. In this peak a great host of spirits are supposed to dwell, but the most powerful are Mandarangan and Darago, a male and a female, who are the patrons of the warriors, and in whose honor human sacrifices are held each year. Other spirits look after the workers in brass and in iron, and the weavers, and some dwell in the fields and protect the crops; while each family has its special protecting spirit. Offerings of food, both cereal and of flesh and blood, are made to all of these, as well as to the low, mean spirits which seek to injure mortals; but to the greatest and most powerful of all the spirits only white offerings of rice and the like are presented. There is also a belief in a class of powerful spirits who inhabit the realms above the earth. These beings take no interest in the affairs of men, and no offerings or supplications are made to them. Each person is thought to have two spirits or souls—one on the right side and one on the left. The first of these finally goes to the land of the dead, while the second continues to roam the earth as a flesh devouring *buao*, or evil spirit.

The Bagobo are ruled over by *dato* or petty rulers, who in turn are subservient to the chief *dato*. Slavery and polygamy are both found in the tribe, but the slavery is of a mild type, and it is possible for the members of this class to become merged into the general population. Agriculture is of great importance, though conducted in a very primitive fashion, but rice terraces are quite unknown.

Going to Northern Luzon, Dr. Cole showed the Igorot and Tinguian living under similar geographic conditions, their territories joining along the northwestern border of Bontoc. The whole belt is exceedingly mountainous, the jungle being absent except in the deep valleys, and the rivers are small except during the rainy season when they become rushing torrents. Under these conditions it would be impossible to support a large population either by hunting or fishing, and the people have taken seriously to agriculture. The rugged nature of the land has caused them to terrace the mountain sides and in connection with these elevated fields, an elaborate system of irrigation has been worked out. Both tribes have, until recent years, been ardent head hunters, but the motives for taking the skull as well as the final disposition of the trophy varies in the two districts. In language and physical type the people are much alike, but there most of the similarity ends.

\*An abstract of a paper read by Dr. Fay-Cooper Cole, of the Field Museum of Natural History, before the Anthropological Society of Washington, and published in the *Journal of the Washington Academy of Sciences*.

A Bontoc village is divided into *ato* or political divisions, each one of which is governed by an oligarchy of old men. The leaders of the various *ato* meet from time to time to decide matters of importance to the village. These *ato* are also exogamic divisions of the settlement and each has its man's house in which all unmarried men and boys must sleep. It also serves as a council house and as the storage place for drums and other ceremonial paraphernalia. Here also are kept the skulls of enemies. Unmarried girls sleep in the *olag* or girl's house, from the age of about four years until their marriage. Trial marriage is common, a final union seldom taking place until the birth of a child is assured.

Going to the Tinguian a radically different type of house construction is encountered. The villages are not divided into political or exogamic groups; the man's house and the girls' dormitory are not found, nor is trial marriage practiced. The government of the village is in the hands of a head man known as *lakay*, who may, if he desires, call in other old men to aid him in the decision of important matters.

### Development of the Timber Industry in Russia

It is well known that Siberia can be called on as one of the leading sources of timber, and stands among the first countries in the world in this respect. This applies to soft as well as hard woods. Before the war these enormous resources were hardly exploited, this being due to lack of railroad facilities and also the insufficiency of storage quarters and docks at the ports of the Amur river. But the war had the effect of developing the means of transport and the maritime commerce of Siberia by way of the port of Vladivostok, and there are now great expectations for the future as concerns the exportation of timber from Siberia. Several large companies have been formed in this country within recent date, with a view of carrying on trade with the extreme Orient and even with Europe, and it is said that before long there will be installed a number of paper mills in this region as well as three large plants for wood pulp. The Russian government is much interested in the development of timber exportation, and it was occupied at a recent date in erecting vast storage quarters for wood exportation at the port of Vladivostok and at the Amur river port of Nicolaievsk, and it is expected to have these finished during the present year.

### The Menace of the Rodent

SOME few years ago when plague was prevalent in California, attention was centered on certain rodents as being the probable factors in the transmission of the disease. It had already been demonstrated by painstaking and exhaustive investigations in India, the traditional home of this terrible malady, that the rat was the main agent in the conveyance of infection to human beings, but during the outbreak of plague in California, it was discovered by the energetic surgeons of the Public Health Service that ground squirrels were also involved in the dissemination of the disease. The late Prof. Metchnikoff during a mission to Siberia, to study the plague, undertaken under the auspices of the Pasteur Institute, came to a similar conclusion with regard to ground squirrels. Varieties of squirrels and chipmunks are believed also to play an important part in transmitting Rocky Mountain spotted fever to man by means of ticks which find a favorite lodging place on the bodies of these animals.

However, the menace of the rodent rests largely, or almost entirely with the rat, and the main disease carried by the rat is the loathsome and deadly malady known as bubonic plague. Innumerable fleas find a refuge with each rat, and when a rodent is infected with the *bacillus pestis*, a certain proportion of the verminous multitude that make their home with the sick rat in turn become infected, and thus not only perpetuate the infection; but, if perchance they come in contact with human beings, insure the direct transmission of the disease.

At the present time, due to conditions brought about by the war, there are numerous vessels sailing to and from New York, which provide most desirable dwelling places—from the rat's point of view. Tramp steamers of every description, some in that advanced stage of decrepitude, which especially appeals to the domestic side of the pestiferous rodent, now make New York their home port. Moreover, owing to the exigencies of war, many old wooden vessels, on the verge of falling to pieces from age and decay, have been pressed into service, and these, with their practical impossibility of disinfection, provide conditions admirably suited to the rat and his filthy habits.

Needless to say the disease-carrying rodent has taken full advantage of these opportunities, and it will be no exaggeration to state that many of the ships which changed circumstances are bringing to New York, and

causing them to lie in the harbor for a considerable time, are swarming with infected rats.

Some of these vessels sail from ports in which plague is endemic and although our own sanitary authorities are competent and constantly on guard, yet at the same time, the situation is menacing to some extent. So far as is known, the rat fulfills no useful purpose. It may be true that he consumes a certain amount of garbage and refuse, but the interests of public health will hardly countenance this method of garbage disposal. At any rate, it is clearly obvious that the best rat is the dead rat, and this fact may be especially emphasized under existing conditions. It has been suggested that it would be well to initiate against the rat a campaign of a world wide character with the slogan "*delendus est mus*."

Every physician should recognize the increased menace and be vigilant accordingly.—From *American Medicine*.

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